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Photo by Mr. P. C. B. Scott Hayward

THE AUTHOR (ON LEFT), WITH MR. BEN NEL (CENTRE) AND MR. LOUIS KRAFT, DISCUSSING HIS PROPOSED TRIP TO THE AUGHRABIES FALLS

AMONG THE WATERFALLS OF THE WORLD

By

EDWARD C. RASHLEIGH

WITH 84 ILLUSTRATIONS

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PREFACE

TO all those persons who have so kindly granted him permission to reproduce their photographs as illustrations in this book, the author has conveyed his grateful thanks in the course of the following pages, as and when such occur, and he thanks them again most sincerely here.

Apart from his acknowledgments to the donors of the numerous photographs, however, he desires especially to thank Mr. R. G. Crone, the Assistant Librarian of the Royal Geographical Society, and Mr. F. Allen, the Map Curator, and his assistants, for the facilities they have so kindly placed at his disposal for general research work ; Mr. W. S. Barclay, F.R.G.S., for much useful information regarding the Parana River and its basin ; Mr. H. D. Rice, Trade Commissioner for Mysore in London, for having so kindly obtained for him the figures for the volumes of certain waterfalls in India ; Mr. J. D. Sears, of the U.S. Geological Survey, for the same regarding the Shohsone Falls ; the Director of the Service Fédéral des Eaux, Bern, for information on the Swiss waterfalls ; Mr. S. Möllerud, of Vassdrags-og Elektrisitetsvesen, Oslo ; Mr. J. Plass, of the Kungl, Vattenfallsstyrelsen, Stockholm ; and Mr. Geir Zoëga, Director of Roads for Iceland, as well as the Norwegian State Railways, for the various statistics regarding the Scandinavian and Icelandic waterfalls ; Captain Ronald Henderson for obtaining for him, through Mr. Sidwell, much valuable data on the Guayra Falls ; Mr. A. D. Lewis, Director of Irrigation for the Union Government of South Africa, and Mr. G. T. Ritchie, Circle Engineer of the Lower Orange River Circle, as well as Mr. Louis Kraft and Mr. Scott Hayward, for information on the Aughrabies Falls on the Orange River ; and particularly Mr. Ben Nel, and his brother and sister-in-law, Mr. and Mrs. Bertus Nel, for having so kindly made him their guest at their farm, Rooipad, during his visit to those falls ; Mr. A. W. M. Brew, the Curator of the Victoria Falls Reserve on the Northern Rhodesian side, for the figures he so kindly obtained from Mr. Fairweather, Director of Surveys for the Northern Rhodesian Government ; and Mr. Paul Ribbink, Librarian at the Parliament Buildings, Cape Town, for further information regarding both the Aughrabies and Victoria Falls.

While most people who have travelled at all extensively on the Continent are no doubt acquainted with the principal waterfalls of Europe, not many, probably, even in these days of increased facilities for travel, have visited more than three or four of what the author has termed the " Giant " Falls of the world ; nor does he himself claim to have done more than that. He believes, however, that in this book, for the first time under one cover, there is presented to the reader a fairly complete account of all the more notable waterfalls of the world accompanied, for the first time again, as far as such are available, by accurate engineers' figures as regards their respective volumes and dimensions.

Some of the facts and certain details herein recorded as regards several of what the author has termed the " Giant " Falls of the world have already appeared in articles contributed by him to various journals and periodicals, such as *The Sphere*, *Discovery*, *The Cape Times* and *The Cape Argus*, etc.

Throughout this book, in comparing the volume of the Victoria with that of other great falls, the author has adhered to the figures of Dr. A. L. du Toit as set out in the *Report of the Kalahari Reconnaissance of* 1925, for the reasons set forth in the chapter dealing with those falls.

E. C. RASHLEIGH

LONDON

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AMONG THE WATERFALLS OF THE WORLD

CHAPTER I

SOME GENERAL CONSIDERATIONS

DISRAELI once wrote that while the contemplation of lakes and mountains in time wearied, that of sylvan scenery never palled. If this observation be true of woodlands, it might be made with still greater force of the ever-changing loveliness of waterfalls. Of all the natural wonders our planet has to show none, perhaps, has made greater appeal to the imagination of mankind in all ages than has the grandeur and beauty of falling water; and the range of emotions evoked by such spectacles has been extraordinarily diverse, whether it be a mere mountain brook like that which babblingly "comes down" at Lodore, or some vast cataract which recalls the nightmare conception of Poe, who envisioned the ocean itself as thundering and shrieking onwards through "stupendous ramparts of ice" towards some unfathomable abyss at the southern Pole. And, unlike mountains and lakes, which, except for the roar of an occasional avalanche or the gargantuan bellowings of the thunder when the Storm Kings enrol their legions, remain always silent and aloof, the great falls are ever vocal, appealing in a thousand variations of sound to the ear, as their irised and constantly changing beauty appeals to the eye.

To the ancient Greeks who, as Lehrs observed, saw in their contemplation of Nature not one god but a world of gods, the swift-rushing streams and cascades were the dwelling-places of radiant Naiads. To the more sombre fancy of the old Scandinavians, they were haunted by Trolls and Demons. Likewise the Japanese of olden times believed in the tutelar divinities of streams, in Demons "who made . . . the foam of the green waters to speak," and, in fine, in a host of spirits who spoke to them in the roar of the cataracts, informing them with unseen and awful being.

So, also, in more modern days great waterfalls have aroused the most lively and superstitious awe among the savage tribes who have inhabited their vicinity. When Mr. H. G. Bryant and

Professor C. A. Kenaston visited the Grand Falls of Labrador in 1891, they were quite unable to induce the Indians to accompany them; the latter averring that death came swiftly on all who dared to look upon the cataract. Similarly George Thompson, the first Englishman to see and describe the Aughrabies Falls on the Orange River in 1824, more than thirty years before Livingstone gazed with wondering eyes on the Victoria Falls of the Zambesi, and who re-christened them "King George's Cataract," remarks that the natives "regarded the place with awe, and ventured but seldom to visit it." While the Neuter tribe of Indians, again, who formerly lived near the mighty "Onghiara," by which name they knew Niagara, believed that the cataract was a veritable Divinity, in whose thunder they heard the voice of the Great Spirit, and in whose spray he had his habitation; and annually, it is said, they offered up to this loud-voiced god the fairest maiden of the tribe and a portion of their crops and of their spoils from the chase.

Nor have the voices of many waters as they fall in diaphanous light and beauty from unscaled heights thrilled the untutored minds of savage races only. A thousand painters and poets all down the centuries have caught their message and have been inspired by it.

"The roar of waters!—from the headlong height
Velino cleaves the wave-worn precipice;
The fall of waters! rapid as the light
The flashing mass foams shaking the abyss;
The hell of waters! where they howl and hiss,
And boil in endless torture; while the sweat
Of their great agony, wrung out from this
Their Phlegethon, curls round the rocks of jet
That gird the gulf around, in pitiless horror set. . . ."

So sang Byron of the Cascate delle Marmore at Terni, extolled also by Tacitus before him in the days of Imperial Rome. One wonders to what heights his Muse might have soared had he been privileged to see any of those falling seas whose volume exceeds that of a hundred such streams as the Velino. These falls at Terni, by the way, though originally the handiwork of man and not a natural cascade, were long considered to be among the finest in Southern Europe; but thanks to modern spoliation, of which they afford but one out of many hundreds of mournful instances, I found it difficult to recognise them from the poet's description, so sadly depleted are their waters in our day.

It is, indeed, the rapidly increasing spoliation, amounting in some cases almost to entire destruction, of so many of the notable waterfalls that has prompted me to the task of compiling this book and to record some descriptions of the most famous of them while they still retain something of their pristine grandeur. In Europe there is scarcely a fall of any consequence which, if not actually attacked, is not at least ear-marked for depredation, notably in Switzerland and, of course, in Scandinavia where the magnificent Rjukanfoss and numbers of his brethren have been largely shorn of their natural glory. The Niagara of to-day is rapidly becoming a mockery of the Niagara that was. Shoshone on the Snake River in southern Idaho, which was long regarded as second only to Niagara in splendour on the whole North American continent, is already, to quote from a letter which I received from Mr. Julian D. Sears, Acting Director of the United States Geological Survey, Washington, D.C., " dry for the greater part of the year, all of the water being diverted through the power house " ; and it is merely a question of time before others even as remote as the Grand Falls of Labrador on the Hamilton River will share the same fate. Such in our mechanical age are the sacrifices which are being made on the altar of so-called " Progress." To take water for irrigation and to make some arid desert blossom like the rose, to which the destruction of the Shoshone Falls is due, at least in part, is one thing ; but to divert it solely for power where there is, as yet, no real or imperative need, as in the case of Niagara, is quite another ; in spite of the specious arguments which are constantly being put forward by the exigencies of politicians or by the grasping greed of a few financiers.

There are, of course, some minds which appear to be so stolid that even the grandeur of such great manifestations of Nature as Niagara, for example, makes no impression on them. One is reminded of the story of the Irish peasant whose good lady, having seen the cataract that day for the first time, was unable to sleep for thinking about it. On her explaining to her annoyed spouse that her restlessness during the night was caused by her wonder at such masses of water falling every moment over the cliff, all the latter found to remark as he gruffly bade her get to sleep was : " Well, phwat's to prevint it ? "

I remember years ago during the heated discussion over what came to be known as " the Niagara Grab Bill " that one of its most zealous supporters, a certain Mr. Merritt, expressed himself as quite willing to see the whole of the water used for power purposes, but graciously would concede that the falls might be "turned on" on certain holidays only, when the workmen might also have the opportunity of witnessing the display! In his *Out-spoken Essays* on *The Idea of Progress* and *The Dilemma of Civilisation*, Dean Inge, in his castigation of the tyranny of the Machine, did not instance the devastation of the great waterfalls of the world as perhaps he might have done, but his observation —"If those philosophers are right who hold that beauty is an attribute of the Deity, and that ugliness of every kind is displeasing in His sight, our modern civilisation is a blatant blasphemy"—does not appear to me to be irrelevant as regards the destruction of such a marvel as Niagara.

The question has often been asked: "Which is the greatest waterfall in the world?" and on hearing it propounded the majority of people immediately think automatically of Niagara or the Victoria Falls as if these two were the only ones that mattered. While others, again, will instance some lofty but slender fall, exclaiming that it is five or six times, as the case may be, as high as the great North American cataract; as if height alone disposed of the question. Such comparisons are, of course, ridiculous; while as regards the prevalent notion that the Victoria Falls are Niagara's only serious rival, the Rhodesian cataract, while certainly of the first order as regards combined height and width, is far inferior to quite a number of others in the important respect of volume, despite frequent exaggerations to the contrary.

It would seem obvious that the really great falls must occur only on great rivers, and this is, generally speaking, true. But exceptions must be made in such cases as those of the Gersoppa and Gokak Falls, both in southern India, which, though situated on streams of little over a hundred miles in length respectively, may yet, owing to the immense rainfall in the monsoons, attain to an extreme flood volume of well over half the mean flow of Niagara. The main factors to be taken into account in any estimate of the pre-eminence, or otherwise, of a waterfall are volume, height and width; and of these the first two are surely the more important, mere extent being a secondary consideration.

It is, perhaps, natural that the wide falls of the world, such as Niagara, the Victoria and those on the Iguazu River, filling the eye as they do by reason of their great breadth, should have been the most often described and illustrated; but, as we shall see, there are others of but slight width which fully rival the above three in point of volume and height, and indeed some of them, though during their flood seasons only, surpass even Niagara, not merely in the latter but also in the former respect. As far as the factor of volume is concerned, Guayra on the Alto Parana is in a class by itself, the Khon Cataracts on the Mekong alone approaching it. Even its low water flow very greatly exceeds the mean of Niagara, while its average yearly volume is far more than double that of the latter. This vast mass of Guayra, however, is divided up into at least eighteen separate falls, so that as regards any single undivided fall the Horseshoe at Niagara, taking its mean yearly volume day in and day out, remains unsurpassed in that respect by any other in the world; that is, of course, in its natural condition and before its waters began to be diverted.

While on this question of volume, it may be remarked that many people are deceived into imagining that great volume is necessarily implied by great width. Once it is realised, however, that of the total volume of Niagara only about six per cent goes over the American fall, and that of the remainder passing over the Horseshoe or Canadian fall about eighty-five per cent is concentrated in the middle third of it, that is to say in the neighbourhood of the V-shaped notch in the centre, it will be more easily understood how a narrow fall, like that of Paulo Affonso on the Rio São Francisco in Brazil, for instance, though under 60 feet wide but possessing great depth and velocity, can yet, in periods of flood, equal or exceed even Niagara in mass.

As I shall frequently have occasion to compare the respective volumes of the various great falls, and as cubic feet per second, usually expressed by the abbreviation "cusecs," may convey but little to the average reader, I may instance as a kind of rough scale of measurement the volume of our own homely Thames. The normal or mean flow of the latter at Teddington Weir is about 2500 cusecs. A moderately high flood may reach to 10,000 cusecs, and an exceptional one, such as that of December, 1929, to between 19,000 and 20,000 cusecs.

The mean flow of Niagara has been variously estimated. It depends, of course, on the level of the waters of Lake Erie from which the Niagara River issues and which seems to vary over different cycles. Thus in 1905, and for about fifteen years previously, Professor J. W. W. Spencer estimated it at 204,000 cusecs; while Mr. Samuel S. Wyer in his pamphlet, *Niagara Falls: Its Power Possibilities and Preservation*, places it at 205,000. I propose, however, as a fairer basis of comparison with the volumes of other great falls, to accept an estimate for Niagara over a longer number of years, namely, 212,200 cusecs, which Messrs. L. G. Dennis and A. V. White in their *Waters Powers of Canada*, published by the Commission of Conservation, Ottawa, 1911, state was the average discharge over the period 1860–1907.

Accepting, then, this figure of 212,200 cusecs, we find that it is equivalent to the *mean* volume of nearly eighty-five such streams as the Thames at Teddington, or to nearly eleven such streams as the latter when in a state of such exceptionally high flood as in December, 1929.

As to the somewhat baffling question which is the greatest waterfall in the world, I fear I must disappoint the reader by not attempting to answer it, but shall leave it to him to solve the problem as best he may. The table which I have given at the end of this book will show the figures for the dimensions and volumes, as far as these are available, for most of what I term the Giant Falls. Indeed, with the exception of Niagara, whose flow, for reasons which I shall mention later, is comparatively constant, the variations in volume of most of the other great falls at their respective high- and low-water stages are so enormous that it is almost impossible to place them in any precise order of precedence. Thus, at dead low-water both the Victoria and the Iguazu Falls may have a lesser flow than that of even the moderately high Thames flood above quoted, less, that is, than 10,000 cusecs; while at exceptionally high water the Iguazu, but not the Victoria,[1] will immensely exceed even Niagara.

The falls of Gersoppa in India, again, not to mention those of Gokak and others, will shrink during the dry season to a most slender volume, yet during the height of the monsoons they will attain to a discharge of 120,000 cusecs, which is not even approached by any other falls of such a height. Still greater may be the variation of the flow of the Aughrabies Falls on the Orange River, though for reasons which I shall set out in their proper place no human eye, save one, has ever seen their surging mass at maximum flood.

With the exception, again, of Niagara which falls into a wide open basin, and similar falls, these variations of volume greatly affect the drops of certain of the other great waterfalls, a number of which plunge down into narrow chasms. The flood water, packed in between the latter's containing walls, piles up immensely, being unable to escape quickly enough. Thus, in the case of Paulo Affonso in the time of ordinary high water, there is a rise of no less than 98 feet in the gorge below the falls, which shortens their normal drop by that amount ; while in the case of the Iguazu the difference of level in "The Devil's Throat," or "The Brazilian Pit" as it is also named, may be greater still.

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[1] Except on the rarest of occasions. *Vide* footnote page 154.

Finally, in attempting to arrive at a solution of which waterfall is entitled to be called the greatest, it must be remembered that many falls vary as well to a marked degree in the widths of their actual water-ways at their dry and spate seasons respectively. The Victoria Falls provide a noteworthy instance of this.

The late Lord Curzon of Kedleston in his chapters on waterfalls in *Tales of Travel* observed that none of the really great falls is to be found in Europe, and it is true that the latter Continent can boast nothing to compare with Niagara in North America, with Paulo Affonso, Guayra or Iguazu in South America, with the Victoria or Aughrabies Falls in Africa, or with the Khon Cataracts or Cauvery Falls in Asia ; none, that is, to compare with any of the above in combined height, volume and width. Yet there are certain falls in Europe, notably in Scandinavia, which, at times, are well entitled to be classed as great falls.

It may be a surprise to many to learn, for instance, that the high flood volume of the Stora Sjöfallet is but little less than the mean flow at the Victoria Falls, while the maximum discharge of the Harsprånget, also on the Lulea River, may considerably exceed it. Or again, to take a more striking example, that the extreme flood volume of the Glommen at the Sarpsfoss in Norway may attain to over 141,000 cusecs. So, too, in Gullfoss and Dettifoss Iceland possesses waterfalls which may be no less formidable in volume than those on the Lulea.

Australia, New Zealand and the various islands in the Pacific, on the other hand, have no falls of outstanding volume, though they boast many beautiful cascades, a few of which, at times of exceptional flood only, may become impressive.

It is in South America, which is, *par excellence*, the Continent of great cataracts, that we shall find the most important waterfalls. Considering its vast size, Asia appears to boast but few really outstanding falls with the exceptions of the Khon Cataracts on the Mekong, the falls of the Cauvery at Sivasamudram, and Gersoppa. For many years, indeed, it was supposed that one of the greatest falls in the world must exist somewhere in the tremendous gorges of the eastern Himalayas, where within a distance of no more than some fifty odd miles the Tsangpo descends over 11,000 feet to reappear as the great Bramaputra in the plains of Assam.

The explorations of Lt.-Col. F. M. Bailey, C.I.E., and the late Colonel Morshead in 1913, and of Captain F. Kingdon Ward in 1924, have now, however, dispelled that romantic possibility. With the exception of about five miles, the whole extent of the gorge has now been seen, and no individual fall has been discovered with a drop exceeding from 30 to 40 feet. As the Tibetans informed Captain Ward that within a short stretch of the river there were seventy-five falls of much the same magnitude but no higher ones, it seems likely that the whole descent of the Tsangpo is made over a succession of such comparatively low falls, and any idea of a first-class gigantic cataract can therefore be dismissed.

It may perhaps be objected that if one includes the cataracts of Guayra and Khon among the world's great waterfalls, one ought not to omit the so-called falls on the Congo which surpass even those of Guayra in mean volume, the great African river being exceeded in its annual discharge by the Amazon alone. The volume at low water, for instance, above Stanley Pool amounts to 30,000 cubic metres per second, or over 1,059,442 cusecs, while the high-water flow will attain to 52,000 cubic metres or over 1,836,367 cusecs.

Though it may seem an arbitrary proceeding, however, one must draw the line somewhere as regards height ; and I do not propose to include as waterfalls, as distinct from great rapids, any which do not have a vertical leap at least in the neighbourhood of 50 feet or thereabouts. While the highest of the falls at Guayra may be 130 feet, varying of course with the river's volume, and the drop of the Don Isom Fall among the Khon Cataracts is 65 feet, none of the sheer descents on the Congo, such as those of Yelala and Ntombo Mataka, appears to exceed from 12 to 15 feet. They may surely be classed, therefore, as gigantic rapids rather than falls.

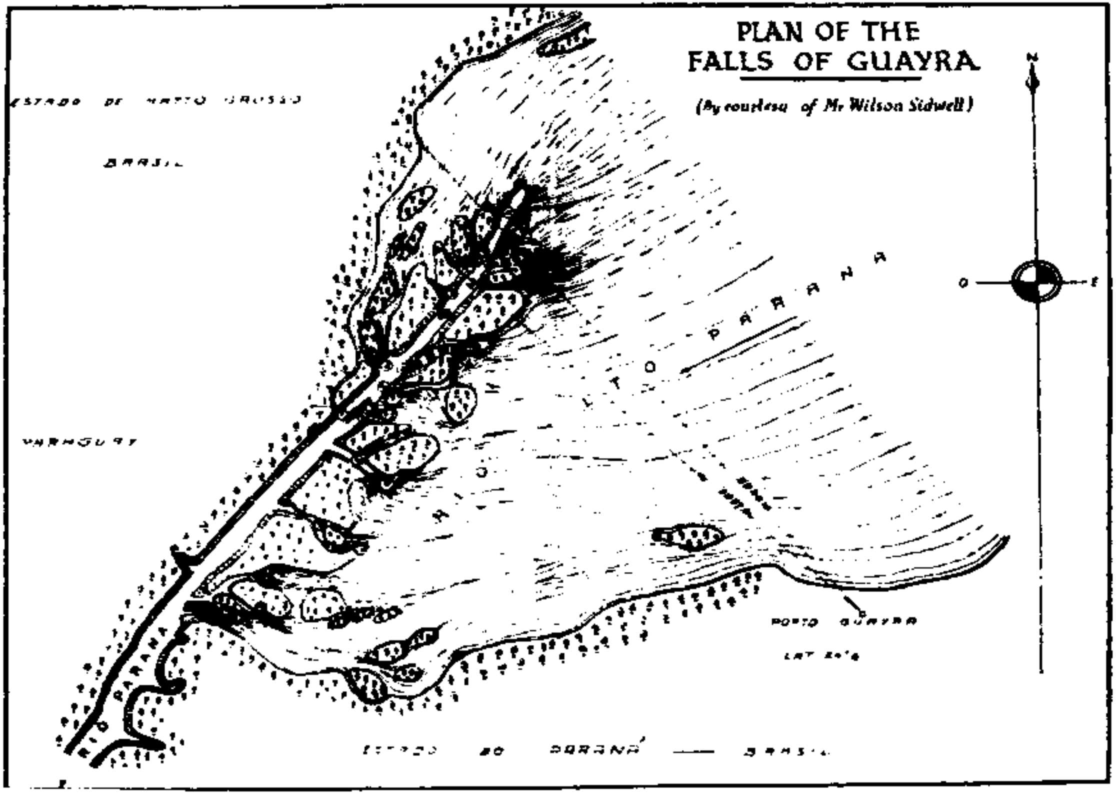
To attempt to describe all the innumerable waterfalls of the globe would require many volumes. I propose in this book to confine myself to the most striking falls on each Continent, dealing first in each case with the major or giant falls and then with the most interesting of their lesser brethren. It will be convenient to take first the South American Continent, and to commence with Guayra, or Sete Quedas, the greatest in volume of all waterfalls, on the Alto Parana.

CHAPTER II

THE SOUTH AMERICAN GIANTS: GUAYRA

SOUTH AMERICA, as I have already observed, is, *par excellence*, the Continent of great waterfalls. Apart from such giants as Guayra, Paulo Affonso and the better-known Saltos of Santa Maria on the Iguazu River, not to mention Kaieteur in British Guiana, which though of considerably less volume than the other three yet exceeds them vastly in height, there are a great number of cataracts, whose very names are scarcely known to the average person, any one of which would be regarded as exceptional if situated in Europe. And of all South America, again, it is the vast basin of the Alto Parana, which lower down as the Rio de la Plata—anglicised into the hideous name of "the Plate"—pours a greater average volume of water into the ocean than any other river of the world, excepting the Amazon and the Congo alone, which probably boasts more falls than any other part of the Continent.

The Rio Grande itself, which at its confluence with the Paranahyba, over 420 miles above Guayra Lake, forms the Alto Parana, possesses a fall, or rather a succession of falls, which is regarded by many Brazilians as the fourth most considerable in their country, namely, the Saltos dos Patos e Maribondo, where the river, over one and a quarter miles wide above its leap and with a volume of 53,000 cusecs, hurls itself down over a total vertical descent of 115 feet. The upper portion, or the Salto dos Patos, is 35 feet in height. Below it an island divides the stream into two branches. One of these plunges down a narrow ravine known as the Ferrador no more than 20 yards wide, dropping a further 80 feet in tremendous cascades, whose spouting foam has been compared to that of heavy breakers on the seashore; while the other branch splits itself up among a number of rocky islets, forming the separate falls of Andorinhas, Taboão, Piracanjuba, Dourados and Sumbi, etc., all of them 80 feet or more in height, and finally re-unites with the rest of the river below the Ferrador's exit. The fall in the latter ravine is called the Salto do Maribondo or "the Hornet's Fall." Here we have at least one notable example of a fall possessing a mean volume greater than that of the Grand Falls of Labrador, and, as well, than that of the Victoria Falls, which is yet hardly known outside Brazil. This great width at the crest contrasted with a very narrow exit below, is a characteristic, by the way, of a great number of South American waterfalls.



PLAN OF THE FALLS OF GUAYRA

(By courtesy of Mr Wilson Sidwell)

Photo by courtesy of Mr. M. Sidic.

GUAYRA

(*Above*) Fall Number 18. (*Below*) Fall Number 1.

Nor have the wedded Rio Grande and Paranahyba, now together forming the Alto Parana, proceeded more than between 40 to 50 miles on their way, when their united mass drops a further 40 feet at the falls of Urubu-punga, "the Gorge of Shining Waters." Though of no great height, the volume has here increased to over 97,000 cusecs, just two and a half times that of the mean flow of the Zambesi at the Victoria Falls, and here again while the perimeter of the falls at their crest is over a mile and a quarter, the water escapes below through an exit of only 54 yards in width.

From here onwards for 375 miles down to Guayra the Alto Parana is navigable throughout, and within this stretch, in which it is said to acquire four-fifths of its total volume, it receives, in addition to an immense number of minor streams, at least seven or eight tributaries as large as, and some of them larger than, the Iguazu which enters it 125 miles below Guayra Falls, contributing a mean volume of over 61,000 cusecs. On nearly all these tributaries, many of which are still but partly explored, there are a number of falls. Thus the Tiete alone, which comes in 10 miles below Urubu-punga, has thirty-six, large and small, including Itapura (40 feet) and Avanhandava (56 feet).

Among those on the Rio Aguapey is the Salto do Dr. Carlos Botelho (over 50 feet), while the Paranapanema has some thirty-three falls, and the Ivahy and the Pequiry, as well, no small number, not to mention others. Swollen by such a number of affluents and with an average rainfall of 79 inches, it is not surprising, therefore, that by the time it arrives at the surging maëlström of Guayra Falls the Alto Parana should have more than quadrupled the volume it had at Urubu-punga and thus should be able to form what is by long odds the most stupendous cataract, or series of cataracts, those on the Mekong alone approaching them, on the face of the globe.

Guayra, indeed, as a glance at the accompanying plan will show, is divided up into at least eighteen separate falls which, with their intersecting islets, extend around both sides of the narrow gorge into which the river plunges for an aggregate distance of at least three miles; it being over a mile from the head of the gorge to the last fall downstream on the right or Paraguayan bank, and quite two miles to the ultimate drop on the left or Brazilian bank.

On the plan, by the way, which, together with the accompanying photographs, has been kindly sent to me through the good offices of Captain Ronald Henderson by Mr. Wilson Sidwell, the former Manager of the Matté Larangeira Company, who resided at Guayra for many years and has made a special study of the falls, it will be seen that the last fall on the Paraguayan side has been numbered 1, and that the numbering has been continued upstream around the head of the gorge and then down the Brazilian bank, on which the last leap is consequently designated as 18.

I have spoken of the right or Paraguayan bank, but as a matter of fact my friend, Mr. W. S. Barclay, one of the leading authorities on the Parana and its basin, who visited Guayra on his return home from Buenos Aires in 1931, where he was General Secretary of the British Empire Exhibition, tells me there is some doubt, to the extent of about 4 kilometres, as to where the boundary line between Paraguay and Brazil actually touches the river. The Brazilians hold that it should come into the gorge just below the falls, the whole of which would then be in their own territory, while the Paraguayans maintain that it enters in the centre of the rapids in Guayra Lake above the gorge's head.

In any event, as the head of the gorge is much nearer the right bank, by far the greater part of the river's volume pours over the Brazilian side of it, where seven of the largest falls are responsible for the cataract being named alternatively " Sete Quedas " ; and hence it follows that the most extensive views are obtainable from the opposite, or so-called Paraguayan bank, so that, as Mr. Barclay has pointed out,[1] it is a matter of some interest to visitors to have the question definitely settled and so free such view-points from the restrictions which any political complications might entail.

Before describing the falls in detail it may be as well to trace their history. Though even to-day far less known to the outside world than most other great falls, it is not improbable that Guayra was the first of any of them to be seen by Europeans. As early as 1527 Gaboto is known to have ascended the Parana as far as the rapids below the falls, and some claim that he actually saw them. It seems fairly certain, at any rate, that Don Ruy Diaz de Melgarejo and his companions must have seen them in or about 1554, at which date the former founded the town of Ciudad Real whose site was only a few miles distant from them.

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[1] For Mr. Barclay's various papers on the Parana and its basin, *vide* the *Geographical Journal* for January, 1909, and February and March, 1932.

It was, later, so destroyed by the Paulistas that scarcely a trace of it now remains.

The best known of the early accounts of Guayra is that of Felix de Azara, who saw them during the closing years of the eighteenth century. The French naturalist, Bourgade la Dardye, however, who visited them in 1887 and described them in his book *Le Paraguay*, says that Azara merely reproduced the account given by a former Boundary Commission of 1788, colouring it with some of the imaginary tales of the Indians. Azara's description, in any event, is not without interest.[1] After stating that the cataract was formerly known as the Fall of Canendiyu from the name of a Cacique who lived there at the time of the Conquest, he writes :

" It is a frightful cascade and worthy of being immortalised by the poets. It occurs on the Parana River ; that river which, lower down, is called the La Plata, and which, even in this part of its course, has more volume than a multitude of the greatest rivers of Europe combined, having in its normal state, at the very point where it makes its plunge, immense depth and a width of 2100 toises, equal almost to a marine league. This enormous width is suddenly contracted to a single channel of no more than 30 toises wide into which the whole mass of the water enters, falling with astounding fury.

" One would suppose that this river, exulting in its volume and in the velocity of its waters, the most considerable in the world, desired to shake the earth to its very centre and to bring about the oscillation of its axis. The waters do not fall vertically or straight down, but on a plane at an inclination of 50 degrees, so as to give a perpendicular height of 52 Parisian feet. The dew or vapour which ascends where the water strikes against its rocky walls and against the projecting boulders which occur in the channel of its descent, is seen at a distance of several leagues in the form of columns ; and near at hand in the sun's rays they form different rainbows of the most vivid colours in which one may perceive a continual tremor. Moreover, the vapours cause a perpetual rain in the neighbourhood. The noise can be heard at six leagues' distance, and one has the impression that the adjoining rocks, which are so sharp as to tear one's shoes to pieces, themselves quake and tremble."

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[1] A good deal of the details here set out as regards Guayra, including my translation of the passage from Azara, and, as well, figures given of the volumes of the various great falls here and elsewhere in this book, appeared in an article I contributed to *Discovery* for September, 1931. I have noticed that much of this material has since been quoted elsewhere, but without any acknowledgment of the source from which it was derived.—E.C.R.

Bourgade la Dardye's own account seems, as a matter of fact, less accurate than that of Azara. He writes:

"Traversing slightly inclined planes, the waters gather themselves in circular eddies, whence they flow in falls varying from 50 to 60 feet in depth; these circular eddies, which are quite independent of each other, range along an arc of about two miles in its stretch; they are detached like giant cauldrons yawning unexpectedly at one's feet, in which the flood seethes with incredible fury: every one of these has opened for itself a narrow orifice in the rock, through which, like a stone from a sling, the water is hurled into the central whirlpool. The width of the outlets rarely exceeds 15 yards, but their depth cannot be estimated. They all empty themselves into one immense central chamber, about 200 feet wide, rushing into it with astounding velocity. . . . A more imposing spectacle can scarcely be conceived, and I doubt whether abysses such as these exist elsewhere in the world; but I must hesitate to go as far as Azara in avowing that the earth all around trembles beneath the feet, or that the vapours that rise amidst the whirlpools descend in incessant rain. As for the noise . . . neither I nor my companions found ourselves deafened by the uproar."

Thundering down in lonely majesty in the heart of the primeval forest, and, except for an occasional visitor from the outside world over long intervals of years, beheld only by the wild Guarani Indians, the ghosts of whose ancestors are fabled to haunt its vicinity, Guayra may be said to have been re-discovered within the last decade or so. To-day, on the Sorocabana railway, the 562 miles from São Paulo to Epitacio on the left bank of the Parana can be traversed in less than twenty-four hours; whence, if one has arranged the matter with the Matté Larangeira Company, a passage can be taken on one of the latter's river-craft, consisting of a steam launch with a houseboat for passengers lashed alongside of it, to the township of Guayra, 220 miles downstream and just above the falls. For travellers coming from Europe or North America this is much the shortest and most direct route, and as well, of course, for the falls on the Iguazu.

Indeed, as an alternative way of reaching Buenos Aires, embracing some of the finest and most interesting river scenery in all South America, including the mightiest waterfall on earth in Guayra and one of the loveliest in that of Iguazu, this whole section of the Alto Parana from Epitacio down to Posadas, a distance of 563 miles, has immense possibilities for future tourist traffic, if and when properly developed ; especially as it lies midway between the thickly populated centres of Rio Janeiro and São Paulo on the north and those of Monte Video and Buenos Aires on the south. The example of Niagara where in certain years the amount expended by visitors, including transportation, has been as much as 25,000,000 dollars per annum, is some indication of what the future may have in store for the region under review whose attractions are incomparably greater and more varied.

From Guayra town, a small but up-to-date community of some nine hundred people, and boasting an excellent guest-house with electric light, telephone, hot and cold water supply and other amenities, there is a short railway through the forest of 36 miles past the falls and their gorge to Puerto Mendes at the head of navigation on the lower river below them, whence a steamer can be taken to Posadas, stopping off *en route* at Puerto Aguirre on the left or Argentine bank of the mouth of the Iguazu River between 80 and 90 miles downstream. This line, of a 2 foot 6 inch gauge, has been constructed chiefly for the carriage of yerba maté, for the collection of which from the surrounding bush country the Matté Larangeira Company, which owns the whole site of the township and the railway, employs between 2000 and 3000 persons.

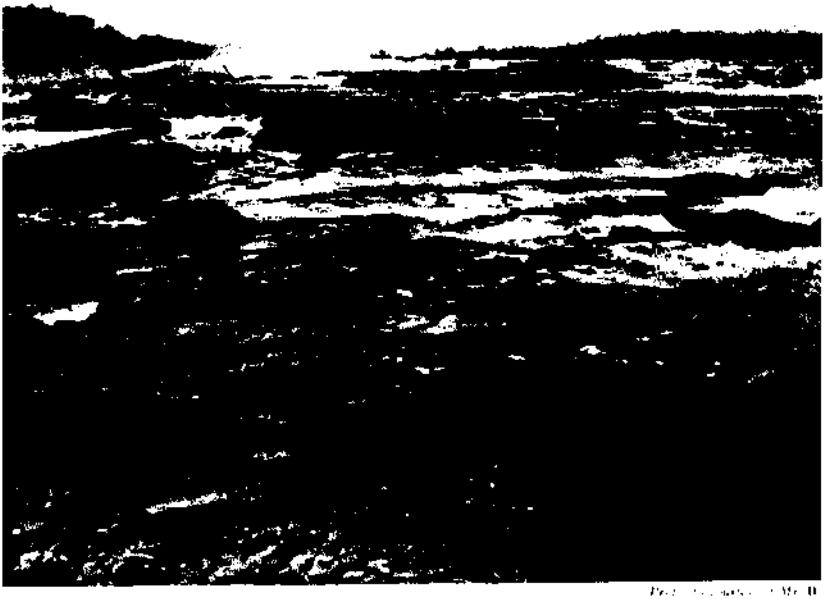
From Puerto Aguirre a motor road, 12 miles long, leads through delightful sub-tropical forest to the Iguazu Falls, after having seen which one can again continue the voyage down the Parana, and can proceed via Posadas all the way by river to Buenos Aires, a distance of 1197 miles, or adopt a quicker route by taking the train from Posadas onwards—710 miles. If one chooses the train, the total distance from São Paulo to Buenos Aires would amount to about 1835 miles, and the actual travelling time, exclusive of stops, to a little over six days. Alternatively, of course, one can reverse this route and proceed homewards by it from Buenos Aires, though in somewhat longer time, against the stream.

But no doubt when the Iguazu-Guayra region becomes properly opened up the easiest and, of course, quickest method of reaching either falls will be by hydroplane, though, owing to the swift current of the river, care will have to be taken in the selection of suitable landing-places. From São Paulo to Guayra in an air line is not more than between 600 and 700 miles, while the distance from most points on the Atlantic coast of the State of Parana does not much exceed 400. There is, by the way, already an air service twice a week from Buenos Aires to Ascuncion, stopping *en route* at Posadas, which is reached in six hours, and from Posadas to Guayra would be no more than a further 240 miles by air.

Apart from the two giant falls at either end of it, that short section of the river between Puerto Mendes and Puerto Aguirre is especially well worth a visit. Here the Alto Parana, with a current of from 4 to 5 miles an hour, and reaching 8 or more in flood, flows in its basaltic bed between banks which average from 230 to 260 feet in height, and within this distance of less than 90 miles there are no less than over forty waterfalls, counting those on both sides, which have drops varying from 50 to 220 feet. Perhaps a score of these can be seen from the steamer's deck, while the others are hidden no great distance away in the side gorges of their respective streams. Several of them amply deserve a separate visit, such as the falls on the San Francisco River (not to be confounded with its mightier namesake the Rio São Francisco to the far north-east) which drop 124 feet with a width of 260, and the 230-foot-high falls on the San Juan River.

The Parana itself, with its innumerable whirlpools, some of which are over 100 feet in diameter, is scarcely a lesser attraction. Navigation, indeed, as one approaches Puerto Mendes is by no means without an element of danger. Some years ago the terminal port was at São João, a little farther upstream, but after a steam tug and barge, with eighteen hands aboard, had been sucked down and totally lost in one of these maëlströms, it was shifted down to Puerto Mendes, where a shallow bay makes a safe approach to the bank possible.

To revert to the Guayra Falls themselves, as will have been gathered, the Alto Parana opens out just above them into a lake-like expanse some 4½ miles in length by 3 in width, known as Guayra Lake. At its upper end the protruding tail of the long and narrow Ilha Grande, which extends for over 50 miles upstream, diverts the bulk of the water towards the Brazilian shore, where, also, the considerable stream of the Pequiry debouches into it. The head of the gorge, which is gradually eating its way back into the bed of the lake, is fairly close to the right bank, and over this head or loop part of the river shoots with frightful velocity, while the rest of the stream, flowing past it on either side, forms



Photo, courtesy of Mr. D

GUAYRA FALLS

Above, Section of the river above the Falls *Below*, A bit of the Mountains

side falls into it for more than a mile downstream on the Paraguayan side, and for double that distance on the Brazilian.

The Aughrabies Falls on the Orange River, as we shall see when we come to them, present a somewhat similar feature, though they carry but little water except when the river is high. But the drop in their case, of course, is immensely greater.

Apart from the fall at the head of the gorge, there are five on the Paraguayan side and twelve on the Brazilian, making in all eighteen separate falls. The majority of them, separated from each other sometimes merely by a gigantic rock, or again by islets of greater or lesser extent, pour into subsidiary troughs or gorges, which slope steeply to the main surging channel ; the impact of the meeting waters causing gigantic waves, which hurl themselves aloft in clouds of shattered spray, and whose tumult, as the currents dive deep into hidden cauldrons, whence they shoot upwards again as if ejected by some volcanic agency, has been compared to the report of distant cannon.

When it is remembered that the main gorge nowhere exceeds from 80 to 100 yards in width, and that the whole force and fury of the Parana goes surging down it at 20 miles an hour, and at still greater speed in the flood season, it can well be imagined that the statement made by Mr. Barclay that the Whirlpool Rapids of Niagara are like a duck-pond in comparison, is scarcely an exaggeration. It is, indeed, this vast volume tossing and roaring down the gorge which, rather than the falls themselves, is the chief spectacle here. The formation is stark, basaltic rock, on the upper fringes of which the high floods prevent any of the sylvan growth which forms so delightful a setting to the more slender and graceful falls of the Iguazu, and its naked savagery adds to the impression of the immense unchained power which Guayra conveys.

Mr. Sidwell, whose long residence at the falls makes him the chief authority on them, has given me some interesting statistics. He tells me that in 1920 a gauge was established above them on which the lowest water-level known up to that date was marked as zero. Yet at a period when the level was between 20 to 30 centimetres only above this zero mark, a Commission of the Brazilian Government, who spent a considerable time measuring the flow in 1921, found it to be no less than 406,000 cusecs. Seeing that the average high-water level reads between 2 and 2·30 metres on the gauge, and an exceptional flood 3·5 metres, it would seem that the mean annual discharge cannot well be less than about 470,000 cusecs, while the flood flow may quite commonly attain to over 882,000 cusecs, and, in exceptional floods such as those of 1905 and 1929, to even double that amount or over 1,765,700 cusecs ! Thus the average mean flow is not merely far more than double that of the mean of Niagara, but it exceeds the *combined* mean volumes of Niagara, Paulo Affonso, the Iguazu Falls, the Grand Falls of Labrador, the Victoria Falls of the Zambesi and Kaieteur rolled into one ! While such an exceptional flood as that of 1905 or 1929 would have a volume equivalent to eight and one-third Niagaras, or to seven hundred and six normal Thameses.

A writer named J. B. Groff, in a contribution to the Italian magazine, *Le Vie d' Italia e dell' America Latina* (December, 1926), has calculated that if it were possible to divert and canalise the whole flood volume at Guayra so as to utilise the total drop of 373 feet which the river makes between the head of the gorge and Puerto Mendes 30 miles below it, one could obtain 174,000,000 h.p., but I do not vouch for the accuracy of the calculation. At such extreme floods, of course, when the river may rise 140 feet or more in the gorge, the falls themselves are wiped out and the whole descent becomes one gigantic rapid.

This 373-foot drop over the 30 miles in question corresponds in some degree to the total drop of the Niagara River, namely, 316 feet, over the 36 miles between Lakes Erie and Ontario. Mr. Sidwell is of opinion that the greater part of it occurs near the actual falls, and indeed two Serbian brothers, Mirko and Stevo Seljan, who published an account of them in 1905, state that the whole of it takes place within a distance of 3 miles from the head of the gorge.

The greatest total height of any individual fall would appear to be about 130 feet at normal flow, and the greatest drop " in the clear " about 65 feet ; but no accurate measurements have yet been taken. The vertiginous fury and tremendous mass of the water, however, amply make up for lack of great height. It is obvious that the drop is greatest when the river is low, and, as I have already mentioned, one must cross to the Paraguayan bank to get the best bird's-eye views ; a proceeding which, as Mr. Barclay has pointed out, is not to be undertaken without due caution, the pull of the current, unless one crosses far enough upstream, being " dangerous for power launches and fatal for row-boats or canoes, as yearly accidents prove."

In their book *The Golden River*, which deals largely with fishing

for the *dorado*, sometimes called the South American salmon, on the Alto Parana, Major Hills and Ianthe Dunbar have described how they crossed over, and then, accompanied by Indian guides well acquainted with the rocky and uneven nature of the river-bed, and provided with poles, rope-soled shoes and bathing kit, waded out for 150 yards, often more than waist-deep and nearly carried off their feet by the current, till at length they reached a rock half-way down one of the lesser falls and overlooking the main chasm. One cannot better their description of the scene, regarding which they observe that it is doubtful if the world holds a more stupendous sight.

"Below," they write, "were the great rapids. The river poured in thunder through the opening, lumps of shattered water, foam and spray, amber and ivory. You cannot compare it to water at all. It was a substance compacted of air and liquid and froth, and yet there was nothing light or foamy or airy about it. The rush and the stress and the drive of it had hammered it into a solidity ; and yet it had not that sameness of outline, that moving solidity, which is given you by the unchanging movement of a great waterfall ; for it was always changing, never the same, tossed and twisted and tortured now into this shape and now into that. At the head of the rapids stands a high rocky island, the safe fortress of many a macaw. Below the island the waters unite and rush down the widening gorge, with waterfalls on either side. As far as you can see are these waterfalls, thundering down, clouded with spray at the base. The air is full of their noise and their foam. It is impossible to convey any idea of the remoteness of the scene. . . . You looked at something prior to man and untouched through time."

I have remarked above that until quite recent years Guayra was but seldom visited except by the Indians of the district, yet for a brief period in the seventeenth century these mighty falls played a part in history, being associated with the story of the abandonment of the Jesuit "Reductions," or missionary establishments, in 1631.

It was in 1586 that the Jesuit missionaries first arrived in what was then known as the Province of Guayra, and in or about 1610 that they founded the first of the numerous Reductions, namely, that of Loreto. For about a score of years these establishments throve and increased, protected as they were by their isolation from the depredations of the Paulistas, or Mamelucos, the name given to rough hordes of half-breeds who inhabited the then Portuguese town of São Paulo, and who were continually raiding the neighbouring tribes of Guarani Indians to secure slaves for labour on their plantations. At one time these various Reductions are said to have had a population of 40,000 Indians, who gladly flocked to them to escape the attentions of the Paulistas. Mr. R. B. C. Graham quotes Voltaire as having written of these establishments: "The laws were respected there, morals were pure, a happy brotherhood united every heart, all the useful arts were in a flourishing state, and even some of the more agreeable sciences; plenty was universal."

But these Rasselasian conditions, somewhat perhaps overdrawn by the French philosopher, were not destined to endure. The Indian tribes near São Paulo becoming depleted, the Paulistas pushed their raiding expeditions farther afield and overran Guayra, burning towns and churches, killing the priests and capturing their converts. It was Padre Antonio Ruiz de Montoya, one of the most learned of the Jesuit Fathers, who became head of the missions in Guayra in 1627, who finally led the remnant of his flock to safety when, owing to the approach of the Paulistas, he was at length obliged to abandon the two chief Reductions, Loreto and San Ignacio, situated near the banks of the Paranapanema, which flows into the Parana some 125 miles or so above Guayra Falls.

It is said that 2500 families were collected at the point on the Paranapanema from which Montoya set out, and that 12,000 persons embarked on the seven hundred rafts and canoes which he had got together. On reaching the great falls it occurred to Montoya that, in order to avoid the labour of making new rafts when they should again come to navigable water below the cataract, a portion of his flotilla might be sent empty over it on the chance of some of the craft being picked up intact lower down. Either he had not fully explored the obstacle he had to surmount, or he was possessed of remarkable optimism; for out of three hundred rafts and canoes which were thus despatched on their journey, an Indian having proceeded along the bank to the lower river in advance, not a single one escaped being smashed to pieces.

How after eight days' march through the inhospitable forest the fugitives, in depleted numbers, again reached quiet waters below the falls; how, saved from starvation by provisions which had arrived from other Reductions on the Parana, they built new craft and re-embarked; and how, after a total journey of nearly 500 miles from their original starting-point, Montoya finally brought them to the neighbourhood of what is now Posadas, where he founded another Loreto and another San Ignacio, provides a stirring Odyssey which need not further concern us here.

I have already mentioned the visit of the Seljan brothers to Guayra. Other accounts of it by Patino, Antonelli, Jermann and Angelo de Rin are not of much value to-day in view of our more exact knowledge. We will now turn to its lovelier, if less mighty neighbour, the falls on the Iguazu, sometimes called the Victoria Falls like their Rhodesian rival, or, more usually, the Falls of Santa Maria.

CHAPTER III

THE SOUTH AMERICAN GIANTS: THE FALLS ON THE IGUAZU

THE first authentic mention of the Iguazu Falls occurs in the *Cronica* of the Jesuit missionary, Padre Lozano, in 1767. He writes:

"Of so strong a current is this river Iguazu that it may not be navigated; and the reason thereof is that at a distance of four leagues from its mouth it is cut from side to side by a precipice of exceeding height where the waters are hurled in such tumult that they may be heard three leagues away . . . and such is the force of this fall that from this single leap there arises a fair cloud which is its perpetual crown and which may be descried from the banks of the Parana."

But though not apparently mentioned till the above-named year it seems fairly certain that the falls were known to Europeans long before Lozano's day. During his memorable four months' march from Santa Catalina on the Brazilian coast to Ascuncion in 1541-2, Alvar Nuñez and his men twice came in contact with the Iguazu River and even camped at the point, twelve miles below the falls, where it joins the Parana. It has, indeed, been stated that on the second occasion that they struck the river the expedition was divided into two parts, one of which proceeded down stream in canoes while the other followed the river-bank. If that is correct they could scarcely have avoided seeing the falls.

The Iguazu Falls may be said to have first gained notoriety among the English and American public at about the time that the railway bridge was opened across the gorge of the Victoria Falls in Rhodesia, when an animated discussion was ventilated in the Press, full of exaggerations and misstatements on both sides, as to which of the two cataracts was the greater. I shall advert to it again when I come to deal with the Victoria Falls.

As regards the Iguazu Falls the most absurd claims were made, particularly with reference to their volume, and especially by certain Argentine writers. Thus Señor Morales, in a pamphlet devoted to a description of them, states quite categorically that their normal flow is 462,692 cusecs, and their flood flow no less than 1,695,360. The majority of English writers on South America who have made any allusion to them have repeated similar absurdities without troubling in the least seriously to consider the full meaning of the figures they have quoted. The statement almost invariably made is that they have double the volume of Niagara, that is at normal flow, and can furnish about 14,000,000 h.p. On the other hand, certain gazeteers, which are notoriously inaccurate in such respects, have underestimated the true length of the river by nearly half, which I must confess I myself, being thus led astray, formerly supposed not to exceed about 430 miles.

On the occasion of his visit to Buenos Aires in 1931, I asked Mr. Barclay if he would be kind enough to procure for me some really reliable data, with the result that he brought back with him, *inter alia*, a most interesting and instructive chart of that section of the Parana River between Puerto Aguirre and Puerto Mendes, and, as well, an official report on the Iguazu Falls, based on exhaustive investigations and measurements by the engineers Humberto Gamberale and Francisco A. Mermoz, which was ordered to be made by the Argentine Ministry of Public Works. This report, which was published at Buenos Aires in 1928, also dealt with the Apipe Rapids on the Parana and with what is called the Salto Grande (though rather a large rapid than a fall) on the Uruguay, but these latter need not concern us here. The figures I shall quote are taken from the report in question and are therefore authoritative.

The correct length, then, of the Iguazu River from its source in the Sierras do Mar near the Atlantic coast, nearly 3000 feet above sea-level, to its junction with the Parana is 820 miles, which is longer than the course of the Zambesi down to the Victoria Falls, while the falls themselves, as I have already mentioned, occur only 12 miles upstream from its mouth. The first 745 miles are wholly in Brazilian territory, and the remaining 75 form the boundary line between Argentina and Brazil. Almost from its commencement near the town of Curytiba, the capital of the State of Parana, which fact has given to it its alternative name of the Rio Grande de Curytiba, the Iguazu is a turbulent and very winding stream. It descends over as many as seven falls before it makes its most famous leap, of which the Salto Santiago and the Salto Ozorio are the most considerable.

Whereas the mean rainfall in the basin of the upper Zambesi scarcely exceeds 30 to 40 inches, in the Sierras do Mar, where the Iguazu rises almost within sight of the Atlantic, it is no less than 157 inches, and throughout its lower and heavily forested basin it averages 79. It also receives quite a number of tributaries, some of them such as the Rio Negro and the Rio Chopim being of considerable size. It is small wonder, therefore, that by the time it reaches the great falls its average volume is far greater than that of its African rival at "Mosi-oa-tunya."

For some way above the cataract the river varies from half a mile to nearly a mile in width. It flows through a maze of innumerable sharp-pointed rocks and islets, covered with coarse dark-green grasses and aquatic mosses. They are scattered about as if thrown down haphazard by some giant's hand, and the water here rushes with great velocity through narrow gaps between them, forming small cascades and correderas ; but, as in the case of the Zambesi above the Victoria Falls, there are no rapids which can compare with the upper ones of Niagara, and still less with the furious, tossing surges that precede the main leap of Paulo Affonso or that of the Grand Falls of Labrador.

At low water, indeed, one can pass above the falls by boat in and out of the various islands from one bank to the other without much risk, though it is impossible to do so at the flood season when most of the rocks and islets are submerged. The normal flood rise here may be anything from six to ten feet, but may reach to sixteen feet at exceptional times.

As it approaches the precipice, the river sweeps around in an enormous irregular and indented curve, making an almost complete half-circle, the diameter of which is some 1300 yards across, and the perimeter, if measured all along the crest through the very numerous intersecting islands, over 3300.[1] It is from the fact that the falls occur on this bend that they derive their great breadth, being, over all, considerably more than half as wide again as the Victoria Falls and over twice the width of Niagara, Goat Island included. It is, also, the distribution of the stream over this great breadth which at comparatively low water, and except for the great Union Fall at the head of the Garganta del Diablo, and the San Martin Falls on the Argentine side, gives a general impression of shallowness to the falls as a whole. They

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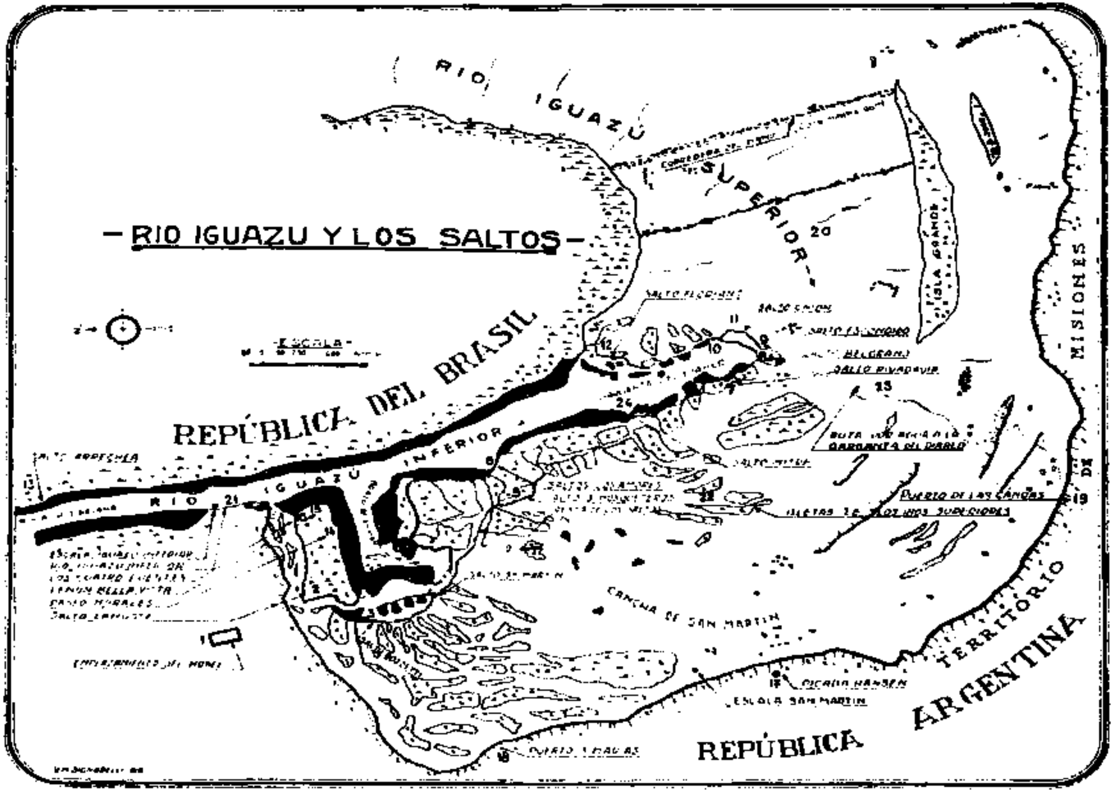
[1] That part of the report of Messrs. Gamberale and Mermoz dealing with the precise width of the falls as measured along their crest, including the San Martin and other islands, was apparently published separately, and, with some other details, was not embodied in that portion of it which was obtained by Mr. Barclay. The figure above quoted of 3300 yards was given to the latter on an earlier visit to the falls some years ago. . . . Mr. Kenneth G. Grubb, however (the author of *Andes and Amazon* and *From Pacific to Atlantic*), who has travelled very extensively in South America, tells me that the figure quoted to him was about 4000 yards ; and, again, Mr. William A. Reid in the *Bulletin of the Pan-American Union*, September, 1916, gives 13,123 feet, or 4374 yards, as the total width, and it may well be that these figures are not exaggerated. If approximately correct, the width of the Iguazu Falls, or rather of the total crest of the chasm over which they plunge, would be more than double that of the Victoria Falls.

Photo. E. N. A.

THE IGUAZU FALLS FROM THE AIR

In the foreground is the gorge of the Devil's Throat [illegible] Argentine Falls



By courtesy of Mr. W. S. Barclay, F.R.G.S.

are, for the most part, graceful, slender and fairy-like as compared with the naked basaltic savagery and immense force of Guayra, and it is their extreme loveliness, set as they are in the heart of the gorgeous sub-tropical forest, which most impresses the spectator.

But the great Union Fall, and only in a slightly lesser degree the San Martin Fall on the Argentine side, is as awe-inspiring as anyone can wish for. The former has always an impressive body of water shooting down from its total height of 237 feet, at normal flow, with tremendous velocity; for here the main current of the river, hugging the Brazilian shore, is of great depth and volume. The waters, roaring and raging, leap furiously into the chasm, and, rebounding again, send perpetually up to heaven that fair cloud of mist of which old Lozano wrote, shot through in the sunlight with a myriad rainbows, or, when the sky is overcast, giving the impression of dense steam surging upwards from some gigantic boiling cauldron.

The best view of this great Union Fall, so called as the boundary line between Brazil and Argentina runs up the centre of the Devil's Throat and intersects it, is from an islet, reached by boat, which projects out on the left or Argentine side of it. Immediately adjoining this islet is the narrow, straight Rivadavia Fall, the highest of all, which plunges at a single leap into the gorge. The broad, curving Union Fall, which extends all around the head loop of the chasm, is a continuation of it. It first leaps down for some 25 feet on to a hidden platform which the river has here eroded at its crest, then jumps off again in one unbroken mass into the depths below.

From this point, too, as a glance at the plan[1] and the air view will enable the reader to comprehend, a complete view can be obtained of the various falls on the Brazilian or opposite side of the chasm, such as the Floriano Falls and many others not named. All of these make a double leap, first plunging down for over a hundred feet on to a projecting platform, which varies in width from a few yards to over fifty, and then making a further leap of about equal height. At low water these delicate, plumed cascades with their background of giant trees, palms and hanging ferns, where hundreds of swallows and brilliantly coloured butterflies flit in and out, make an effective contrast to the greater mass of the Union and Rivadavia Falls; but in times of high water they, too, crash down in immense volume, forming almost one continuous fall.

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[1] In the plan the names of Belgrano and Rivadavia have been mistakenly assigned to the wrong falls.

To the left of Rivadavia, following the chasm down its Argentine side, a number of comparatively slender falls, intersected by many rocks and islets, pour down opposite those on the Brazilian side. Such are the Belgrano Falls, the Three Musketeers and many others. Beyond them, again, we come to the densely wooded mass of San Martin Island, the largest of all the islands which divide up the falls, which projects itself out from the crest of the cliff and slopes steeply downwards to the bottom of the gorge. It is this island which prevents any spectator on the Argentine side from having a complete view of the whole of the falls. Indeed, the only point where any such bird's-eye view can be obtained is from the higher ground on the Brazilian shore, and even then not an entirely complete one.

On the further side of it are the great San Martin Falls, the most considerable in volume of all the Argentine Falls and exceeded in that respect only by the Union. These, also, form a double fall, but here the projecting shelf is so narrow, and the cloaking foam and spray of the descending flood so great, that they give the impression of a single leap. Beyond them again, pouring out from innumerable channels through literally scores of exquisitely wooded islets, are the lesser Argentine Falls, terminating with those known as the Bossetti Falls.

The waters from the Devil's Throat rush down past San Martin Island, on the further side of which they are joined by those which pour over the rest of the Argentine Falls ; and the united river then flows on to join the mighty Parana some 12 miles below.

The average width of the chasm of the Devil's Throat, or, as it is also sometimes named, the Brazilian Pit, is no more than 54 yards. Consequently in times of very high flood the rise here, due to the piling up of the water in so narrow a space, may be very great ; as much, indeed, as from over 100 to even 140 feet, thus decreasing the height of the falls by that amount. These great variations of volume, and therefore also of height, signally distinguish the Iguazu Falls from those of the Victoria or Niagara.

Like the Victoria Falls, those of the Iguazu at dead low water, which usually occurs in May, have a volume of less than 10,000 cusecs, the lowest recorded flow being no more than 7381. This condition of things, however, will last only a few days, and the general low water period for not more than thirty days in any ordinary year. The flood season lasts about eighty days and

[illegible]

IGUAZU FALLS

[illegible]

[illegible]

IGUAZU FALLS

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reaches its peak in October. The average normal flood, which is not occasioned by sudden freshets but by a gradual and steady increase, with approximately an eight-foot rise above the falls, will reach about 167,498 cusecs. But an extremely high flood, when the rise may be sixteen feet, will attain to the enormous amount of 452,029 cusecs; thus, *at such exceptional times only*, justifying the claim of those who have asserted that the volume is double that of Niagara. The mean annual flow is given by Messrs. Gamberale and Mermoz as 1746 cubic metres per second, equivalent to 61,660 cusecs; though they also state that the *probable* mean flow for the period 1876-1921 ("caudal medio probable") was 69,605. It is the former figure, however, which we may accept here for purposes of comparison with the mean flows of other great falls.

The mean flow at the Iguazu Falls, therefore, exceeds that of the Victoria Falls by more than half as much again, and is slightly more than two-sevenths of that of Niagara; while its average flood flow is more than double the average flood flow of the Victoria, and well over three-quarters of the mean of Niagara. It will be noticed that the volume in extreme high flood is more than sixty times that of the absolute minimum.

As regards height, the greatest drop of the falls at normal flow is 237 feet, which at minimum flow may be increased to close on 270. At flood time the height is greatly lessened for the reasons above stated. And finally as regards horse-power it may be stated for the benefit of those who have imagined that the falls could light up the greater part of the Argentine, that at mean flow, which can be reckoned on for 255 days in the year, the horse-power is calculated to amount to 1,214,807, and, at low water, to no more than approximately 182,491.

On the exceptional occasions of the volume attaining to over 450,000 cusecs, it is stated that the horse-power would be about 6,985,170; but personally I confess that this figure seems extremely high, bearing in mind the great decrease in "head" which such a volume would imply. As a matter of fact the Report of Messrs. Gamberale and Mermoz is not in favour of the development of the falls for hydro-electric power, both on account of the great variation in volume and the heavy expense involved in the cost of transmission lines to reach the consumer; the falls being, of course, far removed, at present, at any rate, from any large centre of population. Much the same considerations apply to the case of Guayra, whose situation is still more remote.

I shall mention later in connection with Niagara how for one day only, namely, on March 31st, 1848, the great cataract went practically dry and ceased to flow. Incredibly enough the Iguazu Falls have also ceased to exist, though for widely different reasons, on at least two occasions well within living memory. Both in 1905 and again in 1929 the rise of the great Parana was so enormous—over 130 feet opposite the point where the Iguazu pours into it—that its surplus waters, acting as a dam, caused the whole gorge of its tributary, as well as the great cauldron of the Brazilian Pit, to be completely filled up. The falls were thus temporarily wiped out of existence, and the waters of the Iguazu found their way to the Parana by overflowing in all directions through the surrounding forest.

In the loveliness of their subtropical sylvan setting and in the diversity of their innumerable separate leaps, the Iguazu Falls yield to no others in attractiveness among the great wide falls of the world. They are now being visited by an increasing number of tourists every year, and, moreover, not merely by Argentines and Brazilians, but by a very large proportion of foreigners, such traffic during the decade ending in 1931 having grown from 97 to over 1000 persons per annum. There is no reason why this number should not easily increase to 10,000 annually, and to far more with improved facilities for tourist travel and convenience.

During his recent visit Mr. Barclay prepared some notes on this subject, embodying certain recommendations with a rough estimate of their cost, both as regards the Guayra and Iguazu Falls, which he has kindly allowed me to set out here. As he points out, it would first be essential that the three states which share all the territory involved, namely, Argentina, Brazil and Paraguay, should co-operate for the improvement of through tourist traffic, especially in the matter of passport *visas*, etc., and that the good offices of the Matté Larangeira Co., which, as I have already explained, owns the township of Guayra, as well as the railway, and the steamboats from Guayra upstream, should especially be enlisted. His suggestions include :

1. An air survey of both banks of the Parana along the 90-mile stretch from Puerto Aguirre to Puerto Mendes, which would show the location of all the minor falls, and the cutting of "picadas" through the forest so that the visitor can gain access to them, and, incidentally, be afforded some opportunity of seeing the luxuriance of the sub-tropical vegetation.
2. The construction of foot-bridges between some of the islands

both at Guayra and at the falls of the Iguazu, which should be out of reach of the flood water, so as to give access to viewpoints which are now difficult to approach except by long detours and at some personal risk. At Guayra the Matté Larangeira Co. had, as a matter of fact, constructed several such bridges between Falls 15 and 18, but all were washed away in the big flood of 1929, except one which is now no longer accessible.

Also, as regard Iguazu, the better maintenance and improvement of pathways and descents on the Brazilian side to the first and second levels of the falls.

3. The cutting of a " picada " on the Paraguayan side of the gorge at Guayra.

4. Improved landing facilities at Puerto Aguirre (Iguazu) by the construction of a rope incline such as already exists at Puerto Mendes, and, as well, the erection of a rest-house at its summit, where refreshments could be served and guests await the steamers.

5. The construction of a better motor road between Puerto Aguirre and the Iguazu Falls, and the same on the Brazilian side, which affords a better location. Alternatively, the construction of a light railway, which would give far better service, and be more economical in upkeep, apart from the saving in time.

6. The improvement and cheapening of the existing hotel facilities on the Argentine side of the Iguazu Falls ; while the unfinished hotel on the Brazilian side might be at least partially completed and utilised as a rest-house for visitors.

The above are some of the improvements which Mr. Barclay suggests. He estimates that if about £20,000 were spent on the above lines and proper co-ordination existed between the State authorities and the various local enterprises, the facilities for seeing the two great falls, as well as all the incomparable waterfall country that lies between them, would be immediately trebled, with corresponding effects on the tourist traffic. Such improvements and the removal of the present inconveniences to which the sightseer on the Alto Parana is unnecessarily subjected would be the best propaganda ; for the comments in the visitors' book at Iguazu, by people of wide experience and reputation, leave no doubt as to the Alto Parana constituting, so to speak, the world's chief waterfall centre.

Later, perhaps, when funds were available, suspension bridges might also be built over both gorges below the two respective falls, which would, of course, give far easier and less hazardous access to both banks. The Guayra gorge, indeed, would be incomparably the easiest and least costly site for any bridge across the Parana along its whole stretch of over 1600 miles from Buenos Aires to Urubu-punga.

Before leaving this Iguazu-Guayra region I may add that in the not too distant future it may be possible to proceed, at least to Guayra, all the way by railroad from the Brazilian coast. As Mr. Barclay has pointed out, the State of Parana has at present no line which feeds its long hinterland abutting on the Parana River. It would not be difficult to build a westward branch to this point from the existing main railway running between São Paulo and the Uruguayan border which traverses the Atlantic plateau from north to south.

CHAPTER IV

THE SOUTH AMERICAN GIANTS: PAULO AFFONSO

WERE I given the choice of seeing just one, and no more than one, of the giant waterfalls, I think I should certainly decide on Paulo Affonso; with the proviso that I should not be restricted to a single visit, but might be allowed to view it at its different stages of low, medium and high water. Of all the great waterfalls in the world there is none that is so protean in its diversity; none whose compressed and surging mass inspires awe and wonder to so great an extent as this. Yet, strange to say, it is far and away the most neglected and, as far as any accounts in English are concerned, the least described of all the great falls. While, apart of course from Niagara, pages have been devoted to the glories of the Victoria and Iguazu Falls, this marvel of north-eastern Brazil remains unhonoured and unsung, and in the innumerable books which have been compiled about South America during the last forty years it is usually dismissed in a few lines or with a bare mention. Even the late Lord Curzon, a great lover of waterfalls, omits to mention it at all in his short summary of the world's chief falls, though he must surely have perused Burton's *Explorations in the Highlands of Brazil.* Buley's *Handbook to northern South America*, to give a further instance, never even alludes to it; while another work, entitled *If you go to South America*, by H. L. Foster, which apparently professes to be a guide to the chief attractions of Brazil, merely dismisses the falls, and that quite inaccurately, by remarking that they "are nearly two hundred feet in height, but scarcely justify the journey, which may take altogether about ten days!"

Paulo Affonso did indeed come into its own in the 'fifties and 'sixties of the last century, when we had the separate accounts of Halfeld and Liais, two engineers who made different surveys of the course of the Rio São Francisco on which the falls occur; and notably in 1869, when the famous traveller, Sir Richard Burton, published the work above alluded to and wrote by far the best English account that has yet appeared. A little later, in 1874, there appeared in the *Bulletin de la Société de Géographie* of Paris a description, of course, in French, by the Abbé Durand; but since about 1890, when Frank Vincent wrote a short and rather inaccurate account in his book, *Around and about South America*, I have been able to trace only three others: one by the

Hon. H. W. Furniss, then U.S. Minister to Haiti, who had made several visits to the falls at their different stages, which appeared in the *Bulletin of the Pan-American Union* for January, 1910; a short account by Miss Agnes Chase in the *Annual Report of the Board of Regents of the Smithsonian Institution*, Washington, 1927: and, quite recently (June, 1933), a further short description by Mr. Kenneth G. Grubb in his book, *From Pacific to Atlantic*. These three, the last two of them no more than a couple of pages each, appear to be the only ones in English which have been printed for well over the last forty years.

Nor are the falls by any means inaccessible. They are no more than 150 miles inland, as the crow flies, from the Atlantic and the mouth of the river, and can be reached to-day without much difficulty in several different ways. They are, however, certainly off the beaten track of the tourist, who would have to make a special detour either from Pernambuco, Maceio or Bahia to see them. In short, they are not "on the way" to anywhere else. They are located, moreover, on the border of the parched, semi-arid and not otherwise particularly attractive region of the Brazilian "North-east"; which reasons, taken together, probably account for their having been so little visited by Europeans in recent times.

Of this uninviting district, indeed, known as the Sertão, or Desert Plain, Mr. Grubb has written in his *Amazon and Andes*: "Every year the arid season or summer places a fatal limit to prosperity and progress. The streams dry up, the pools of fœtid water stagnate or disappear, vegetation dies, branches droop in nakedness, the dust blows across the plains in clouds, and all nature is burnt. There is no shade, no refreshing green, no rich or fruitful plantation. The means of life become scarce, man instinctively tenacious of his crumbs."

The Paulo Affonso Falls are unique in being situated much further down the course of the river on which they occur than are any other great falls. The Rio São Francisco is over 1800 miles in length, exceeding any river of Europe except the Volga alone, and it has already traversed more than 1600 miles of its course where it makes its astounding leap. It is the longest river that has its total course from source to mouth wholly in Brazilian territory, and is reckoned by some geographers to be the sixteenth or seventeenth in magnitude among the rivers of the world. In its lower course it is navigable up to Piranhas, about 40 miles below the cataract; in its upper course, where it averages a mile and more in width, and not infrequently overflows its banks during the floods to an extent of six and even ten miles, it is navigable from Jatoba, a similar distance above the falls, for over 1100 miles up to Pirapora, whence a railroad runs to Rio Janeiro, 628 miles distant. A branch of the Great Western of Brazil Railway Co., some 72 miles in length, connects the lower river at Piranhas with the upper river at Jatoba and passes within about 10 miles of the falls, the station for which is approximately half-way between the above-mentioned points.

The most interesting route by which to reach Paulo Affonso is to proceed either to Pernambuco to the north of the river's mouth, or to Bahia, about a similar distance to the south of it. From either place a coasting steamer is then taken to Penedo, a port about 30 miles up the river ; whence, again, one can proceed by a small double-decked stern-wheel steamer, or by a "Canoa," to Piranhas, where the railway begins. Alternatively, one can approach it from the opposite direction by taking the train from Bahia to Joazeiro, over 350 miles, and thence go by river for the 180 odd miles down to Jatoba where the railway ends. A third and less interesting route is to go by rail either from Pernambuco or Maceio to Garanhuns, 168 miles in the former case and 117 in the latter, and thence go on, a full day's run, by motor car. The last of these routes is a good deal the shortest of all, but the roads leave much to be desired.

The "Canoa" above mentioned, by the way, consists of a large native sail-boat with a cabin thatched with palm leaves in its forward third. Such a craft can carry as many as a score of oxen or horses packed crossways ; but it takes a skilful pilot to navigate it, for the current of the river, confined more and more between the hills as one proceeds upstream, is very swift and is strewn with submerged rocks and islets. With the aid of the wind, which always blows upstream in the daytime, this trip from Penedo to Piranhas occupies a couple of days.

Piranhas, the head of navigation on the lower river, is situated a little below the exit of the great cañon which confines the São Francisco from immediately below the falls for a distance, including its windings, of about 42 miles. This cañon is thus rather longer than the one below the Victoria Falls and, generally speaking, is far deeper. In places its savage and inaccessible cliffs rise to a height of 570 feet, and sometimes, according to the Abbé Durand, even to over 800. He describes these beetling walls as overhanging the roaring torrent like gigantic arches, and mentions no less than seventeen separate descents of the river between the foot of the falls and Piranhas, which he calls "les dix-sept degrés de cette immense cascade qui conduit aux pieds du géant Paulo Affonso." As the width of the gorge is often less than 100 yards, the depth and velocity of the imprisoned waters is immense.

On the assumption that Niagara excavated its seven-mile gorge in 4000 years, Burton assigned 24,000 to the kindred task of the Rio São Francisco. As we shall see later, however, a more modern calculation for Niagara is 39,000 years, which, if we assume an equal rate for the excavation of the Brazilian chasm—an assumption which is entirely arbitrary and very possibly quite erroneous —its age would be extended to 234,000.

As a foretaste of what is to come, the São Francisco River starts its career at its very source in the Serra da Canastra in the State of Minas Geraes with a fall known as the Casca d'Anta, or the "Écorce du Tapir." The infant stream shoots out from a fissure at the summit of a "cirque de murailles à pic" in a lovely sheet of clear water into a natural and foaming basin below, whence it descends into its valley by a succession of steps. In its long course it receives a great number of tributaries, the chief of which are the Rio das Velhas, or the River of the Old Women, and the Rio Grande, which joins it 24 miles above Joazeiro, and is the last it receives of any size above the falls. This latter river is interesting as, in the same way that there is a connecting link between the Orinoco and the Amazon River systems by the well-known natural Casiquiare Canal, so here the Rio Grande by its affluent the Rio Preto connects through the Sapão and the Somno with the Tocantins River, thus also affording communication between the Amazon and the Rio São Francisco.

Below Joazeiro the São Francisco's basin narrows. The river passes through the arid region of the Desert Plain, and is subject to intense evaporation, so that its volume during the droughts shrinks considerably: a fact which probably prevents Paulo Affonso's mean volume from being exceeded alone by that of Guayra and the Khon Cataracts among all the great falls of the world, though, as we shall note later, it is probably the fourth greatest in that respect after Guayra, the Khon Falls and Niagara. In places below Jatoba the width of the great river contracts from well over a mile to narrow rocky channels no broader than a brook, but of immense depth. We have an example in Europe of the same sort of thing in the case of the Rhone at its famous Perte below Bellgarde, where the Malpertuis flows in a channel of less than 5 feet in width but nearly 92 in depth. Burton observes that these extraordinary narrows are characteristic of nearly all the Brazilian rivers he had seen.

A remarkable instance of them is afforded at the Cachoeira of Itaparica, over 30 miles above the great falls. The formation of the river-bed here, indeed, where the stream at low water has a total drop of nearly 69 feet, strongly resembles the upper stage of Paulo Affonso itself. A grim ridge of black sandstone with a base of pink syenite bars the way from bank to bank, through three openings in which the river dashes madly in streaks of foam. So narrow are they that in the height of the droughts a man with a leaping-pole might cross the entire river dry-footed, though in flood the whole bed becomes a roaring torrent.

Enormous pot-holes or cauldrons yawn in the rocks, which radiate intense heat and are polished with a black glaze from the iron and manganese held in solution by the water, so that they resemble cast-iron rather than stone. Some of these cauldrons are 15 feet deep by 7 or 8 in diameter, and many of them contain crystals and exquisitely polished stones resembling gems. It has indeed been said that diamonds have been occasionally found in them. Somewhat similar cauldrons, as we shall note later, are to be seen in the gorge of the Aughrabies Falls on the Orange River, which, though differing widely from them, have yet, as regards their surroundings, certain features much like those of Paulo Affonso.

This is particularly the case as regards the rocks and ravines across which, at least in Burton's day when there was " not even a hovel in the vicinity " and local guides were scarce, one had to find one's way to reach the falls.

The Abbé Durand wrote of the approach to the great cataract :

" No road leads you to it. You will have to seek it for a long time. At length the roar of the water "—which, by the way, he states elsewhere can be heard as far off as the Fazenda do Cruz, more than 14 miles away up river—" reveals to you its proximity. You think you have located it ; it is an illusion. You have still to scale crevasses, galleries, labyrinths and natural stairs ; to pick your way between columns and arcades hollowed and chiselled by the flood waters in the sides of the rocks which form the flanks of this terrible abyss."

But the way is easier to-day, the side ravines being now bridged by a narrow trolley-line which gives access to the small trapeze-shaped island which abuts on the true river-bed, and from which one can behold the great rapids and get a partial view of the fall. On this island is placed the power plant and a few houses belonging to the employees of a cotton-spinning company, the Companhia Agro Fabril Mercantile, which has harnessed about 1600 h.p. of the 2,000,000 or more which Paulo Affonso is calculated to be capable of providing. The ravines one has to cross are, for the most part, dry at low water, but become raging torrents during flood, when the waters which pour down them leap directly over the side of the chasm to join the main river below the great fall.

These side gorges and the above-mentioned island, by the way, are on the left or Alagoan side of the river, which here divides the latter State from that of Bahia. I am not aware that anyone has ever viewed the cataract from the right or Bahian bank. Burton, indeed, whether truly or not, was told that access to it was not possible from that side. From his description of them, the ravines themselves connote an air of magic which, as he says elsewhere, " is the natural expression of the glory and majesty, the splendour and glamour of the scene."

" The stones," he writes, " polished as if they were mirrors or marble slabs, glittered and reflected the burning sunbeams: in places the ridges are walls of turned and worked rock that looks like mouldings of brass, bronze or iron. Many of the boulders are monster onyxes, or granite banded and ribboned with quartz: they are of an infinite variety in size and shape, in make and hue, rough and smooth, warm-red, rhubarb-yellow, dull black and polished jet."

The name of the first European to see Paulo Affonso is not recorded. The mouth of the Rio São Francisco was discovered and the river baptised in 1501. Later, its upper valley was to some extent explored by bands of roving Paulistas who were unaware that it was the same river. The falls were at any rate known some time before 1589, though not then named; but the origin of the name itself is uncertain.

Burton states that some make Paulo Affonso a missioner-shepherd " who was hurled down the abyss by the wolves, his 'Redskin' sheep." Halfeld quotes the story that he was a friar who, while crossing the river above the rapids, fell asleep in the canoe which bore him. His Indian pilot, being unable to manage the craft, was drawn into the current and went down, never to be seen again. But the friar who, *mirabile dictu*, neither woke nor felt the least inconvenience, floated ashore below the falls, and, when picked up, was found still asleep and without any recollection of what had happened! Others, again, say that Paulo and Affonso were two brothers who were the first to settle near the falls and so gave their name to them.

Paulo Affonso consists of stupendous rapids, probably the greatest on earth, which descend for over 70 feet, followed by an awe-inspiring fall where all the combined waters of the river, compressed into a channel less than 60 feet in width, plunge down in a gigantic column for a further 192 feet. Thus, though not of the enormous mass of Guayra, it has the impressive advantage of being a single great fall instead of being divided up into eighteen separate ones.

The breadth of the river about five miles above the falls is a mile and a quarter, where the ordinary flood rise will attain to 13 feet, and the rapids and fall occur within a distance of from 300 to 400 yards. Thus the total descent, according to the measurements of Halfeld, whom Burton quotes, is 262 feet; but Liais and the Abbé Durand respectively make it to be 275 and 279 feet, and both are in agreement that the height of the main fall alone is 197. Mr. Furniss assigns to the latter 190 feet. I have mentioned these figures with some particularity as, with the exception of Mr. Furniss, who paid several visits to the falls at all stages of the river, the three other modern accounts since Burton's time tend to convey the erroneous impression that Paulo Affonso has no great fall, but is rather a series of gigantic cascades.

Thus, Frank Vincent, after speaking of "the tumultuous grandeur, at once beautiful and frightful" of the scene, writes: "Paulo Affonso, of course, partakes more of the nature of gigantic rapids than of falls. At least, one discovers no vertical tumbles over precipices throughout the distance of a quarter of a mile and the 260 feet in which the river changes its level." It is evident, however, that he never saw the great fall, as he says further on that "the grandest rapid as it tumbles nearly at right angles to the general direction of the river is not visible." To add to confusion, on the very next page he mentions three large falls lower down on the right bank, which, he says, "drop for quite 200 feet and are remarkably fine."

Miss Chase, also, after describing the cataract as the greatest waterfall she had ever seen, remarks that it "is not one straight fall, as is Niagara, but is, rather, a stupendous cascade." While lastly, Mr. Grubb, while quoting the total height as 273 feet, and characterising the main fall as being "stupendous in the mass, volume and velocity of its waters," goes on to say that "it is not perpendicular, but is really a rapid on an incredibly savage scale," etc.

The latter, however, with whom I have discussed the point, has since written to me that he did not mean to convey the impression that Paulo Affonso was merely a rapid, and describes it as rather "a set of falls." He adds: "a *part* of the main fall appears more like a rapid." He further tells me that at the time of his visit the river was exceptionally high and that an English resident at Garanhuns who accompanied him and who had seen the falls very many times said that he had never seen so much water passing over them. Now during the *average* flood flow the rise of the river some distance above the falls, where it is about a mile and a quarter in breadth, will amount, as I have already mentioned, to about 13 feet, and this is known to involve a corresponding rise of no less than 98 feet in the narrow gorge immediately below the main fall. Thus anyone seeing it at that period would view it shorn of half its normal height.

At such a time, moreover, the immense depth and thickness of the water at the brink of the fall, less than 60 feet wide, and the ever-ascending spray-cloud which veils its face, would still further have the effect of making the height seem less than it actually is. As an example of this, let the reader turn to the photograph of the Twin Falls on the Snake River facing page 102. It would, I think, be difficult for him to realise that the left-hand fall there depicted, whose upper part comes down at a sloping angle much like Paulo Affonso, is 187 feet in height, but so it is.

The centre of the Horseshoe Fall at Niagara, also, where the depth of water before diversion attained to 20 feet or more, affords another instance of the way great mass may seem to detract from height; and at the crest of Paulo Affonso in the flood season the depth of water may be easily double that amount, if not more. The view of the latter here shown will give some idea of its enormous mass, though I have been assured that both the photograph in question and, as well, the more distant one of the whole fall, both of which were taken at comparatively high water, quite fail to convey adequately the real volume, at that period.

Apart from these considerations, again, it is extremely probable

Photo by courtesy of the Great Western of Brazil Railway Co.

PAULO AFFONSO

A distant view of the main fall. Above, on the left, is the Angiquinho Fall. On the right, wedged into the cliff, is the Power House of the Cia Agro Fabril Mercantile.

that the crest of Paulo Affonso may have worn down considerably since the fifties and sixties of the last century, so as to give it a more sloping effect. This has certainly happened during the last thirty-five years in the case of the Grand Falls of Labrador. It is a pity we have not got good photographs taken in Burton's day to compare with modern views, which would almost certainly reveal a marked difference.

Burton himself, perhaps, may have unintentionally fostered the idea that Paulo Affonso is rather a huge rapid than a fall by his observation that " if Niagara be the monarch of cataracts, Paulo Affonso is assuredly a King of Rapids," and also by his not infrequent allusion to this Brazilian marvel as " the Great Rapids." It is an impression, however, which could be gathered only by a careless reader, seeing that he describes the main fall at length and quoting Halfeld's measurements, specifically states its height, apart from the upper cascades, to be 192 feet.

The falls are not caused, as Burton has pointed out, by any break of the river through a mountain range, which does not here exist, but they are set in the heart of a dry and stony plain, covered with thick scrub, in which the waters have carved out an immense fissure. After the freshet sets in, this plain is green with grass and gay with many-coloured flowering plants which then burst into bloom. Especially curious is the Cabeça de Frade, or " Priest's Head," the name given locally to a variety of melocactus which has a red top-knot resembling a Turk's fez. But as soon as the dry season commences everything withers again except the spine-bristling cacti, against which the local cattleman, or Sertanejo, protects himself and his horse by leather suits, breast-plates and anklets, etc.

As I have already observed, Paulo Affonso is Protean in its diversity. Though the shape and contour of the main fall changes but little, except for its decrease in height in the flood season, the aspect of the rapids above it varies in a marked degree at the different stages of the river. Side ravines, also, which are practically dry at low water become roaring torrents during high, and, leaping over the sides of the chasm, form additional falls. It is difficult, for these reasons, to outline any consistent plan of Paulo Affonso.

The one given by Halfeld in his *Atlas e Relatorio concernente a Exploracão do Rio do São Francisco* is very unsatisfactory, as it fails to indicate clearly the exact positions either of the upper cascades or of the main fall. It is generally agreed, by the way, that the former gain greatly in beauty at low water, though their might and fury must be unquestionably more impressive during spate.

Above the falls the river flows through a veritable "dédale" of rocks and islets, of which latter the chief are Forquilha, Feito and São Gonçalo. It is the latter, also named by Miss Chase "Secret Island," a dark, wooded mass of gneiss and granite, which at the point where the descent begins divides the river into two unequal branches. The right-hand one, which is much the smaller, flows around the back of this island, keeping to the right, or Bahian bank, and on the same level as when it left the main stream, till the greater part of it suddenly turns at right angles to the left, crosses, or rather subdivides the island, and shoots down at a slanting angle and from a vertical height of 72 feet into the mäelström of what is known as the Mãi da Cachoeira, where it joins the rest of the river right upon the brink of the main fall. This separate cascade is known as the Cachoeira do Angiquinho, or the Bahian Fall.

The remainder of this branch flows on, to pour in a sloping cataract into the grand cañon further down. The rest and far greater mass of the stream surges down on the left or Alagoan side of Secret Island in a deep quebrada or ravine, the black southern face of the island, which rises from 70 to 80 feet above the river, forming one rock wall of it, and the Alagoan bank the other. The river, flowing from north-west to south-east, commences its descent, much as at Itaparica, by pouring through deep but narrow gaps between two or more rocky islets and making a drop of 32 feet.

At the base the torrents converge towards each other, clash together in furious cross-currents, and then go surging tempestuously towards the left or Alagoan bank, where there is formed what is called the "Vai-Vem do Cima," the upper "Come and Go"; a kind of bay or inlet where the water ebbs and flows like a miniature sea. At low water its sandy bed invites to a bathe, but it is treacherous to a degree, and cattle who have ventured into it have often been swept away. Nothing, indeed, if once entangled in the toils of Paulo Affonso, has the least chance of escape, and even dead and battered fish are frequently noticed floating in the lower river at Piranhas.

Deflected by the iron-bound, rocky bank, the whole mass then swirls over to the south-west, plunges down in sheets of foam into a second cauldron or chaudière, and then, divided up into

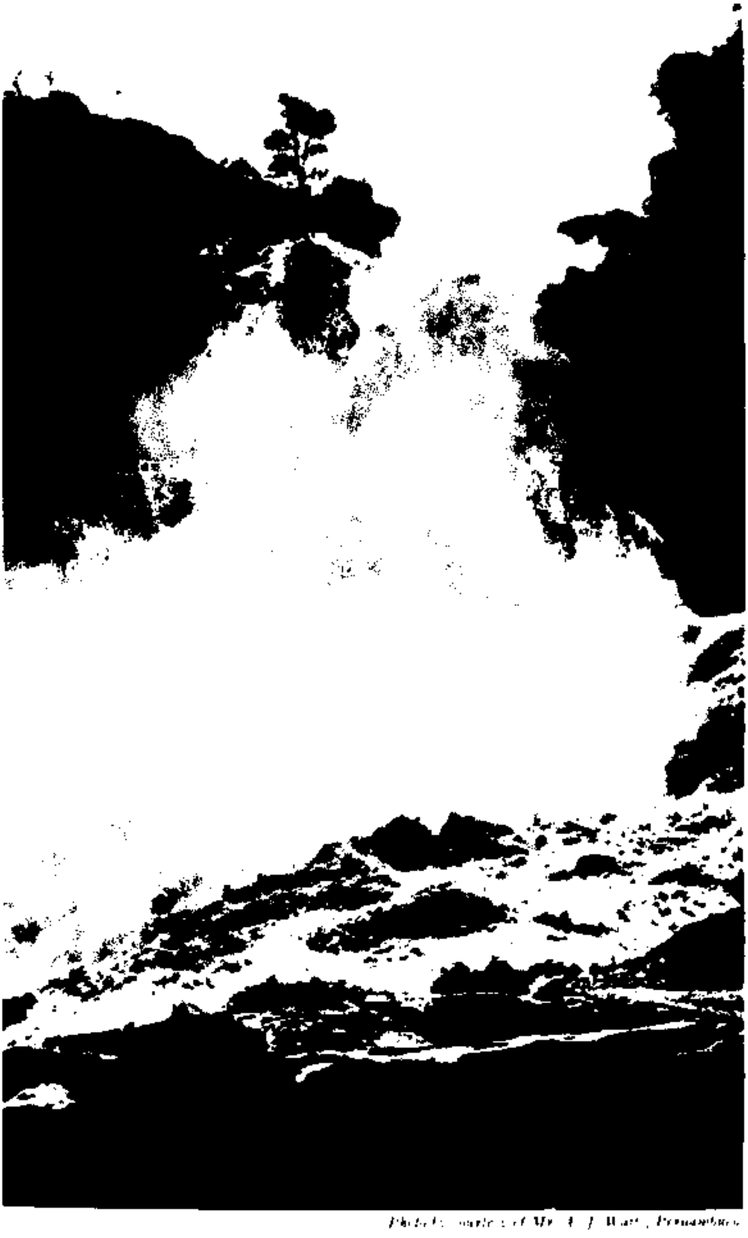


Photo by courtesy of Mr. A. J. Watt, Pernambuco

PAULO AFFONSO

The Balcão or Angiquinho Fall plunging down into the Mãe da Cachoeira close to the brink of the main fall.

four narrow channels by ridges of rock, which at low water rise from 30 to 50 feet above the stream, it rushes down a steep incline with an almost incredible velocity and with a fury that, as Mr. Furniss observes, "almost causes the earth to shake and with a roar that can be heard for miles." The total vertical descent here is just on 50 feet, which, with the 32 feet of the first drop, gives the so-called rapids an aggregate descent of 72 feet. I say "so-called" rapids, because as a matter of fact this upper portion of Paulo Affonso rather consists of gigantic cascades than of true rapids. Be that as it may, Burton's description of them as "a King of Rapids" is certainly not undeserved, for, as Frank Vincent truly remarks, "there are none greater on earth."

Neither Niagara, the Victoria nor Iguazu Falls can show anything which can begin to compare with the spectacle which we have here. The nearest approach to them, perhaps, are the rapids which precede the great leap of the Grand Falls of Labrador, but there the volume, of course, is generally far less – incomparably less than that of Paulo Affonso's flood season – and they descend down a straight V-shaped chute, which has neither the twists nor the turns, nor the cauldrons, nor the serrated ridges, nor the jagged towers of rock which impede and make so marvellous the descent in the case of the Brazilian cataract.

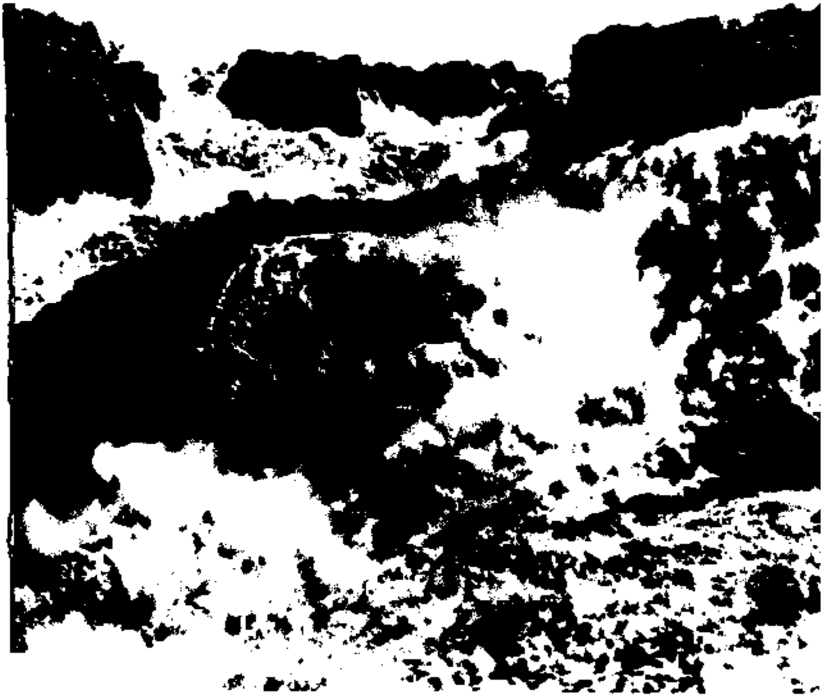
"It is a spectacle," writes Burton, "of a host rushing down in 'liquid vastness' to victory, the triumph of motion, of momentum over the immovable. Here the luminous whiteness of the chaotic foam-crests, hurled in billows and breakers against the blackness of the rock, is burst into flakes and spray that leap halfway up the immuring trough. There the surface reflections dull the dazzling crystal to a thick opaque yellow, and there the shelter of some spur causes a momentary start and recoil to the column, which, at once gathering strength, bounds and leaps onwards with another crash and another roar. The heaped-up centre shows fugitive ovals and progressive circles of a yet more sparkling, glittering, dazzling light, divided by points of comparative repose, like the nodal lines of waves. They struggle and jostle, start asunder, and interlace as they dash with steadfast purpose adown the inclined plane. Now a fierce blast hunts away the thin spray-drift, and puffs it to leeward in rounded clouds, thus enhancing the brilliancy of the gorge-sole. Then the steam boils over and canopies the tremendous scene. Then in the stilly air of dull warm grey, the mists surge up, deepening still more, by their veil of ever-ascending vapour, the dizzy fall that yawns under our feet."

The view showing part of the rapids at normal flow will give some idea of what the immense increase in volume must be in full flood when the enormous rocks and ridges are almost entirely submerged. At the latter time, also, additional falls may pour down into the quebrada over Secret Island from the Bahian branch of the river on the further side of it.

After rushing down the quadruple-channelled incline as above described, the four branches of the river unite and speed madly onwards to the spouting cauldron of the Mãi da Cachoeira, meaning "the Mother of the Falls," where they are joined by the fifth or Bahian branch, which here tumbles into it, forming the separate fall of Angiquinho above mentioned. The whole united mass, now confined within a width of less than 60 feet, dashes furiously at an opposing rampart of rock, is thrown back by it, and then in clouds of spray and, to quote Miss Chase, with "a deep vibrating roar with a high continuous clashing above it, like endlessly shattering glass," topples over at right angles into the chasm more than 190 feet below. So tremendous is the displacement of the currents of air at the brink of the fall, forming what Durand calls a *trombe d'air*, that both he and Liais state that it is impossible to cast a stone against it for a greater distance than some 18 feet. No matter how vigorously you hurl it, it is stopped or sent back by the wind; a fact which formerly caused the inhabitants of the vicinity to believe that the cataract was enchanted.

An air of magic and a deep impression of "realised" power—"power tremendous, inexorable, irresistible," as Burton expresses it—are, indeed, the perdurable impressions which Paulo Affonso conveys to all who have seen it. There is a further and more gloomy suggestion, also, of the former attribute in the Draculean cavern, the "Furna do Morcego," which has been hollowed out of the left-hand cliff of the gorge a little below the great fall. For this Furna do Morcego, as its name implies, is the gathering-place of thousands of horrible vampire bats who infest the surrounding plains and attack the sleeping cattle, and even sometimes men, creating wounds which soon become incurable ulcers.

In places, according to Halfeld's measurements, this cavern reaches to 90 feet in height, with a width of nearly 30 and a length of over 318. It is reached at low water only by descending the



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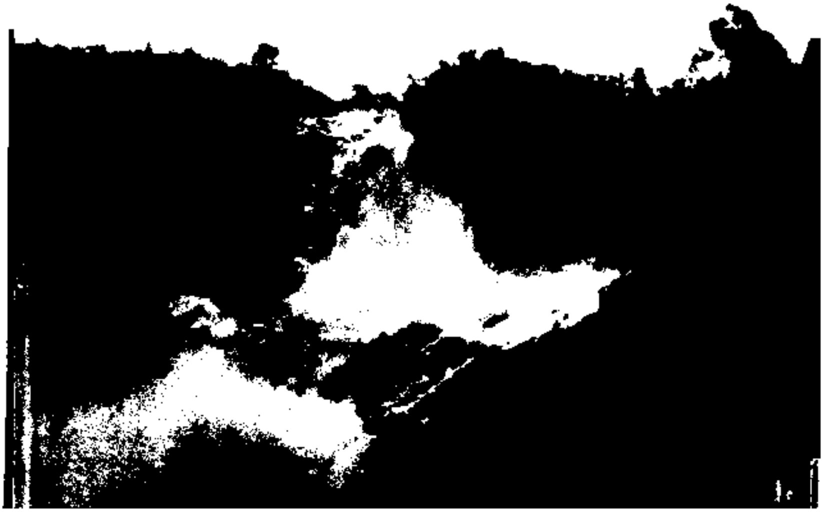
PAULO AFFONSO

(Above) The Upper Rapids or Cascade *Below*—The Crest of the Main Fall

Photo [illegible]



dry bed of one of the ravines on the left bank of the river, down which in flood time there surges an additional torrent which forms a fall that curtains the cave's entrance. At the latter, piles of logs of trees and other débris collect after the freshets; and as soon as the waters had sufficiently subsided, the cattlemen and their neighbours used to collect these in a great heap, to which they set fire in order to destroy the bats; but as a rule their efforts had but indifferent results.

Here, too, is the "Vai-Vem do Abaixo," the lower "Come and Go." The Abbé Durand relates that the grinding of the logs, as the ebb and flow of the water rubbed them against each other and against the rocks, created such a tumult that one could hear it from quite a distance away; though one would certainly have supposed that the roar of the fall would have deadened any such sound. It is said, by the way, that a natural arch formerly spanned the gorge below the fall, and that since it collapsed the roar has been less. Reclus alludes to overhanging projections of rock which he says: "Semblent indiquer l'existence d'anciens ponts naturels franchissant jadis la gorge avec 80 ou 100 mètres de portée."

From the mouth of the Furna, also, one has a view of the lower third of the fall, its upper part being almost hidden by a buttress of cliff which projects out from the Bahian side of the chasm. The depth of the kieve which the descending mass has here hollowed is said to be 86 feet. The imprisoned flood at the base of the fall makes a stupendous tempest of waters. It continues to rush forward at a considerable downward slant for several hundred feet, then striking the 300-foot-high wall of the gorge, forms a huge whirlpool and surges off at right-angles, boiling and dashing down the cañon in the direction of Piranhas.

Such is Paulo Affonso, the King of the Rapids and the Niagara of Brazil, at once the most diverse and awe-inspiring of all the world's great cataracts, which Durand describes as representing "dans toute la force du terme une magnifique horreur."

Paulo Affonso, however, has one great disadvantage, and that is, as if to accentuate its mystery, that it is very difficult to get any good view of the main fall in its entirety. From the trapeze-shaped island mentioned above on to which one crosses by the trolley planks, one can look down from a height of 72 feet on to the spouting Mãi da Cachoeira and, by grasping a tree and leaning well forward, get a glimpse of the edge of the cataract as it plunges over into the abyss for 190 feet and more—a view which Mr. Furniss has described as too awe-inspiring to be pleasant;

also, from the entrance of the Furna do Morcego, one can see the lower part of it. But there is no really complete view. The rather distant one here reproduced was taken from the Alagoan bank, in common with the others, from a point 300 feet above the level of the water in the gorge, and close to what is known as the Emperor's Seat, which latter is the place whence Dom Pedro liked best to view the cataract on the occasion of his visit in 1859, and where a stone has been placed in commemoration of that imperial event. But, as will be noticed, the projecting buttress on the Bahian side of the ravine greatly obscures the fall.

As regards the mean annual volume at Paulo Affonso, it has been difficult to obtain reliable figures. The Belgian engineer, Liais, states that the flow at the mouth of the river, *at dead low water and after six months' absolute drought*, is approximately 99,000 cusecs; and as the São Francisco receives no tributaries of any size between the sea and the falls, it might be deduced from this that the minimum volume at the latter would not be much less. It has to be remembered, however, that the falls occur at just about the dividing line between the semi-arid region, which extends for a considerable distance above them, and the far more rainy zone on the coastal side, so that the dead low volume at the falls themselves may be considerably less than at the river's mouth.

An engineer's report, which I was allowed to see through the courtesy of the Great Western of Brazil Railway Company, states that the *minimum* flow at Joazeiro, between 180 and 190 miles above the falls, was about 46,428 cusecs, but went on to say that the flow at the falls at the same period would be considerably in excess of that figure; though how much more it was not possible to say, as it had not been found practicable to take any measurements in the actual vicinity of the cataract.

Another report by the engineer Magalvio da Silva Todrigues, an epitome of which was sent to me by Mr. A. J. Watts of Pernambuco, to whom I am also indebted for two of the photographs here reproduced, stated that the discharge at Jatoba, less than 40 miles above the falls, was approximately 53,000 cusecs, but it was not clear at what stage of the river. The same report also stated that at the falls themselves even in the greatest droughts the volume never fell below 1000 cubic metres per second, or about 35,315 cusecs; an amount, be it observed, which is far in excess of the minimum flows of both the Victoria and Iguazu Falls, either of which may fall to under 10,000 cusecs.

The ordinary flood volume, which lasts from four to five months from November to March, is generally stated to be at least five times and sometimes ten times the low-water flow, and during exceptional floods it is immense. Thus, the Abbé Durand records rises of close on 40 feet both in 1792 and in 1843, of 26 feet in 1836, and of 33 feet in 1852. On such occasions the river will overflow its banks in places for as much as 10 miles or more.

Taking, then, one factor with another, it seems fairly safe to conclude that the *mean* yearly volume at the falls must be somewhere in the neighbourhood of at least 100,000 cusecs. If, for example, we assume that for as much as five months of the year it is no more than about 40,000 cusecs, about 75,000 in a more or less normal state for three months, and some 200,000 during the remaining four months of flood, we would get an average per second throughout the year of just under 106,000 cusecs. The figure suggested, if we except the Khon Cataracts on the Mekong, would assign to Paulo Affonso the third place as regards mean annual volume among the great falls of the world, Guayra and Niagara alone surpassing it. In such high floods as the Abbé Durand records the extreme volume might easily attain to 500,000 or more.

Schemes have of course been proposed to harness Paulo Affonso to a far greater extent than has hitherto been done by the Companhia Agro Fabril Mercantile of Pedra, and the construction of a hydro-electric plant of not less than 200,000 h.p. has been suggested. It has also been proposed to inaugurate a vast system of irrigation, though the undulating nature of the surrounding country would appear to render any such undertaking far from easy of accomplishment.

CHAPTER V

THE SOUTH AMERICAN GIANTS: KAIETEUR

THOUGH the volume of the celebrated fall of Kaieteur on the Potaro River in British Guiana is far less than those of the three colossi we have been considering, that volume taken in conjunction with its unusual height well entitles it to a place among the major falls of South America. Indeed, it is fairly certain that no fall in the world of equal height exceeds it in respect of its *average* flow, which is more than four times that of its Indian rival Gersoppa, to which it comes nearest in any general comparison. The latter, however, surpasses even Kaieteur in altitude, and as far as the *flood* volume of the two is concerned is then incomparably greater, thanks to the enormous rainfall during the monsoons.

Kaieteur is by far the most noteworthy of the numerous falls which are found in the highlands of the colony. It was first discovered in 1870 by Mr. C. Barrington Brown while he was engaged in making a geological survey in that region, and in his book, *Canoe and Camp Life in British Guiana*, he thus describes his first view of it as he came upon it during his descent of the upper Potaro:

" Making a detour to the right through this grove," he writes, " we came out on the flat rocks at the head of the great fall, and walking to the edge of the precipice, down which the water was precipitated, I gazed with wonder and delight at the singular and magnificent sight that lay before me. Not being prepared for anything so grand and startling I could not at first believe my eyes, but felt that it was all a dream.

" There, however, was the dark, silent flow of water down which we had travelled, passing slowly but surely to the brink of the great precipice, and breaking into ripples as it approached its doom. Then curving over the edge in a smooth mass of a brownish tinge, changing into snow-white fleecy foam, it was precipitated downwards into a black seething cauldron hundreds of feet below. . . . The Potaro was swollen at the time by the late rains, and where it poured over the curved edge of the fall it was over 100 yards in width, containing a vast volume of water, which, as it reached the basin below, sent up great creamy spurts of foam with a steady thundering roar. A dense mass of mist rose from the western side of the foot of the fall, which, whirling upwards above the top, was caught by the wind, and blown like a cloud-scud over the savanna, while a smaller one rose from the eastern edge."

On his return to Georgetown his account of this hitherto entirely unknown fall, of which it was thought that, had it really existed, some report would have been brought long before by the Indians to the civilised world, aroused considerable interest and incredulity; with the result that the then Governor, Mr. (afterwards Sir John) Scott, ordered him to return and to make a thorough examination of it. He accordingly went back that same year, accompanied by Sir George Young and Messrs. Mitchell and King. They reached the fall at a time when the river was again flooded, and took measurements which gave the following results.

The total height was found to be 822 feet. Of this, 741 is a sheer leap from the crest of the fall to the pool, and the remaining 81 feet consists of a sloping cataract from the further edge of the basin down to a still reach of the river below. The width at the brink at that time of high water was 369 feet, and the depth in the centre of the river about 200 yards above the fall was just over 20 feet. In the dry season, when the flow is much less, the width at the crest narrows to 120 feet or less. Barrington Brown gives no estimate of the volume, but it has since been stated, presumably as a result of actual measurements, that the discharge is 23,400 cusecs,[1] which is very considerably more than the flow of the Thames even during a very exceptional flood. I have not come across any estimate of the volume at the height of the rainy season, but no doubt it would exceed by a good deal the figure above mentioned.

The Kaieteur Fall, then, is in every respect a formidable one, and, indeed, with the exception of Gersoppa, no other fall of equal height can probably rival it. It may be added that its available horse-power, reckoned as equivalent to 60 per cent of the actual water power, has been stated to be 1,300,000.

A curious feature of the fall, on which many observers have commented, is its comparative and unexpected silence, at least, at low water, to anyone surveying it from above. This, of course, is due to the great depth of the drop and the sound-deadening effect of the clouds of mist which arise from the far-off cauldron below. At such a time the water, "graceful as a ceaseless flight of innumerable rockets," seems to glide dreamily over the edge of the abyss, descending in lace-like wreaths of foam, which form and re-form themselves continually into a thousand different shapes. And behind the thinner parts of this immense shifting veil one can get fleeting glimpses of the great black cavern behind the face of the fall, hollowed out for ages in the sandstone cliff by the rebound of the waters after they strike the surface of the pool. At such times it is like a scene of enchantment : the magical amphitheatre in which it is set, the tapering, swaying veil of gleaming water falling from that lofty height, and, beyond, the winding ravine clad on either side with dense vari-coloured forest.

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[1] This is presumably the mean annual discharge, though it is not clearly stated.

But changed indeed is its aspect at flood time. The late Sir Everard im Thurn, who visited the fall both at the low- and high-water seasons, has well described the contrast.

" It was," he writes, " a very different scene from the last time. Then it was beautiful and terrible ; but now it was something which it is useless to try to describe. Then a narrow river, not a third of its present width, fell over the cliff in a column of white water, which was brought into startling prominence by the darkness of the great cave behind ; and this column of water, before it reached the small, black pool below, had narrowed to a point. Now an indescribably, almost inconceivably vast curtain of water—I can find no other phrase—some 400 feet in width, rolled over the top of the cliff, retaining its full width till it crashed into the boiling water of the pool, which filled the whole space below ; and, at the bottom, of this pool itself only the outer edge was visible, for the greater part was ceaselessly tossed and hurled up in a great and high mass of surf and foam and spray. . . . It is impossible even to hint at the overpowering effect which the whole scene produced."

The view showing the falls in flood is, by the way, from a photograph by Sir Everard which Lady im Thurn has kindly permitted me to reproduce.

As I have mentioned in connection with other great falls, Kaieteur was, in those days at any rate, an object of superstitious awe to the neighbouring Indian tribes ; and Sir Everard has described how he failed to induce any of them to guide him and his party to the fall, and how, even in carrying their woodskins down past it, they would make a detour of five or six miles rather than go near it. To-day, however, the natives seem to have got over their fears. The late Mrs. A. F. Walter, to whom I am indebted for the view of the fall at low water, showed me another

Photo by the late Mrs. A.

KAIETEUR. Height, 741 feet.

(*Above*) At low water. (*Below*) In flood.

Photo by the late Sir Leonard .

view depicting some of them actually bathing, in the dry season, among the numerous rocks just above the brink. These rocks, mostly overgrown with weed, can be made out in the photograph here shown, and Mrs. Walter told me that at the period in question it was a matter of no great difficulty to cross by them from the one bank to the other.

The proper spelling of the name of the fall, by the way, should be "Kaietuk," or, according to the late Dr. Bovallius, a Swedish savant who for some years made a home for himself at a place which he named Holmia, situated near the junction of the Potaro and the Chenapowu some distance above the falls, "Kaijituick," an Indian word meaning "Old Man's Rock." The Indian legend in connection therewith is not particularly romantic.

They relate that in former times an old Indian lived in a village above the cataract and had become an intolerable nuisance to his youthful relations, who were constantly having to perform the unpleasant task of extracting the "jiggers" which were always accumulating in his feet They accordingly resolved to expedite his departure to a better land, where no doubt "jiggers" were not, and placing him in a wood-skin with sundry of his household goods, they sent him over the fall. He was never seen again, which is scarcely surprising, but shortly afterwards the wood-skin appeared below in the shape of a pointed rock, while on the western edge of the pool there also appeared another large square boulder which they declared to be the pegall, or canister, in which his goods had been packed.

As a matter of fact, the sides of the great ravine below the fall, whose sandstone walls tower up to a height of 1100 feet and more, as well as the whole floor of the amphitheatre, are littered with enormous rocks, largely concealed by the thick sylvan growth, which must have crashed down with tremendous force from the heights above. Sir Everard im Thurn propounded an interesting theory to account for them. He noticed in the hard conglomerate layer of rock, of which the ground about the summit of the falls is formed, a number of long, narrow and extremely deep fissures lying at right angles to the bed of the river and resembling very narrow crevasses in a glacier. This conglomerate casing overlies the bed of the softer sandstone, and, as he says, the usual theory has been that the wearing away of this hard roof by the constant passage of the water is what has caused the fall to recede.

He considers, however, that the process is more probably owing to "occasional, sudden catastrophes;" for assuming, as seemed to him likely, that such fissures occurred across the bed of the river itself, some part of the water would trickle through them into the great cave below, and so gradually widen them, with the result that the conglomerate would form not a roof, but a bridge, over the cave. In time such a bridge, or succession of bridges, would collapse, and its fragments would account for the piles of boulders on the floor of the amphitheatre.

The Potaro River, on which this great scenic glory of British Guiana occurs, is one of the many tributaries of the great Essequibo up which part of the route to the falls from Georgetown, the capital of the colony, formerly lay. Though no more than 200 miles or so distant from the latter, the round trip to Kaieteur used to take about ten days and involved many changes. The first leg of the journey was by steamer to Bartica, whence one proceeded up the Essequibo in a so-called "tent-boat," a substantially built wooden vessel with an awning for protection from the sun, and equipped with a motor-car engine.

The river is of considerable width, its banks clad with dense forest on either side, and the numerous small cataracts swirling among sunken rocks necessitated an ever-watchful eye on the part of the pilot. Indeed, the trip was by no means always free from accidents, though as Mr. Allen, who has been in charge of the construction of the new bridge over the Potaro at Garraway Stream, tells me, these occurred far more often in ascending the river than on going down it; and consequently, for those who elect to proceed to Kaieteur by the new route of which I shall presently speak, an alternative return journey through the lovely forest scenery which borders the Essequibo can be well recommended.

To continue our description of the old route, after reaching the mouth of the Potaro, a narrower and more picturesque stream, one proceeded up it some ten miles to Tumatumari where a cataract bars the way and where one could stay the night at a bungalow hotel. About a similar distance further on at Potaro Landing, or Garraway Stream, the launch service ended. From the latter a road of a couple of miles, succeeded by a forest trail of four miles, took one to Kangaruma, where the river was rejoined, and one could continue by a small boat to Amatuk, where again there is a cataract that sweeps around two sides of a small island.

From Amatuk, by making an early start, it was, and is, possible to reach Kaieteur the same day, thus dispensing with a halt for the night at the mosquito-infested point of Turkeit, where all navigation of any kind ceases. To reach the summit of the Kaieteur plateau, a climb of about 1500 feet is involved, but only a small part of this is really arduous.

To-day, however, the above route has been considerably shortened by the construction of a road of 102 miles in length direct from Bartica to Garraway Stream, and by a steel suspension bridge over the Potaro at that point, beyond which the road is continued for a short distance to Kangaruma. It is, indeed, proposed to extend this road up to the falls, a further 34 miles, but I am not aware that such extension has yet been authorized, and in any event its construction would involve considerable difficulties. The itinerary, for details of which I am indebted to Mr. J. W. Spiller, Chief Engineer (Designs), Crown Agents for the Colonies, Westminster, is now therefore as follows :

1st day : Leave Georgetown 7.20 a.m. by steamer and rail. Arrive Bartica about 3 p.m.

2nd day : Leave Bartica by motor lorry at 7 a.m. Arrive Garraway Stream 6 p.m.

3rd day : Leave Garraway Stream about 8 a.m. and motor to Kangaruma ; thence by launch, and sleep the night at Turkeit.

4th day : Arrive at Kaieteur.

Though, as Mr. Spiller tells me, organised trips to Kaieteur have not yet been completely arranged, persons wishing to make the trip can do so, on application to the General Manager of the Transport and Harbours Department, British Guiana, at rates varying from $160 for a single traveller to $76 per head for parties of not less than ten for the round trip, inclusive of all first-class transportation, meals and sleeping accommodation.[1]

In an article which appeared in *The Times*, December 16th, 1930, Sir Edward Denham, the Governor of British Guiana, pointed out that it had long been the hope of the administrators of the colony to make Kaieteur a health resort, much like the hill-stations in India, for which the Kaieteur savannahs, being situated at an altitude of from 1200 to 2000 feet above sea-level, would be admirably suited in contrast to the low, swampy and humid climate of the coastal region. Referring to the new road above mentioned, he wrote :

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[1] I am informed that quite recently an air service has been inaugurated from Georgetown to the falls.

" It will not merely be a tourist route, it will pass through much valuable auriferous country between the hills of Omai and Kaburi, from which over 120,000 oz. of gold has already been extracted. It will enter the Potaro district, the gold output from which amounts to over 500,000 oz., and from which 70,000 carats of diamonds have been obtained. It will also be possible to tap the balata industry which lies away to the south-west, but uses the Essequibo River as its means of transport. . . . To-day there are only a few hundred people in the district, but their numbers increase as discoveries of gold and diamonds are made, and are restricted mainly by the present difficulties of transport."

The Kaieteur Fall, then, may yet prove indirectly to be the lodestone which shall bring greatly increased prosperity to British Guiana.

CHAPTER VI

SOME FURTHER NOTEWORTHY FALLS OF SOUTH AMERICA

THE falls we have discussed in the preceding chapters may be termed pre-eminently the Giants of South America, and all of them, with the exceptions of Paulo Affonso and Kaieteur, belong to the Parana basin. In this basin, the Baron Homem de Mello and Dr. Francisco Homem de Mello in their *Atlas do Brazil*, published in Rio de Janeiro in 1909, enumerate some 109 falls, and in the Amazon basin 150; that is to say, of course, in those parts of each basin which lie within Brazilian territory. In the eastern Brazilian basins, of which that of the Rio São Francisco is the most extensive, they mention between 80 and 90 falls. Many of these so-called falls, however, come under the category of great rapids rather than of waterfalls; and, further, owing to the difficulty of obtaining precise information as regards the dimensions of many of them, the figures given are not always to be relied upon.

Though on account of their lack of height we can scarcely reckon them as falls, we must mention here the cataracts on the Madeira River which, within a distance of about 287 miles, drops, in all, over 475 feet. According to the engineer Keller, the width of this part of the river varies from 400 to 2200 yards, with a discharge of 305,616 cusecs and a maximum depth of no less than 122 feet. Of the various descents, which may roughly be compared to those of the Congo, the falls of Theotonio are perhaps the most impressive. At this point the river is broken by outcrops of intensely black rock which vividly contrast with the white foam of the leaping flood. The waters descend at a general inclination of 45 degrees, but near the right bank where the volume is greatest the vertical drop is stated to be about 36 feet. The old Indian name of the Madeira, by the way, was the Caiary; but the former appellation, meaning " wood," was given to it by the Portuguese on account of the great number of floating logs and trees which they found in its waters near the junction with the Beni River.

On the Xingu and the Orinoco there are also many cataracts of a similar order to those on the Madeira, but no great leaps; though I may mention here a fine and formidable fall on one of the latter's tributaries, the Caroni, which occurs near San Felix about 5 miles above the junction of the two rivers.

To continue with the Amazon basin, the late President

Roosevelt, in his expedition through the unexplored wilds of Western Brazil, in the course of which he descended and mapped the then almost unknown "River of Doubt," or Aripuana, one of the most considerable tributaries of the Madeira, was the first to make generally known to the world two exceptionally beautiful falls which had originally been discovered by Colonel (now Field-Marshal) Rondon, who accompanied him on part of his trip. These, curiously enough, are situated within no more than 8 miles of one another, and are known as the Salto Bello and the Utiarity Falls. The former is on the Rio Sacre and the latter on the Rio Papagaio, both of which rivers flow into the Juruena, the name given in its upper course to the mighty Tapajos, which, again, is an affluent of the yet mightier Amazon.

Of the Salto Bello, Colonel Roosevelt wrote: "The river, after throwing itself over the rock wall, rushes off in long curves at the bottom of a thickly wooded ravine, the white water churning among the black boulders. There is a perpetual rainbow at the foot of the falls. The masses of green water that are hurling themselves over the brink dissolve into shifting, foaming columns of snowy lace."

According to the measurements of Lieutenant Lyra, this fall is 129 feet high and 378 wide. Its crest shows remarkable regularity, and the dark-red sandstone gorge into which it plunges admirably contrasts with the varied tropical vegetation amidst which it is surrounded.

But more imposing still are the Utiarity Falls, the Salto Bello's near neighbour, which are so named after the Sacred Falcon of the Parecis Indians who inhabit the district, and Colonel Roosevelt doubted if any falls in North America, except, of course, Niagara, excelled them in grandeur. He describes them as being twice as high and twice as broad as the Salto Bello, but according to Lieutenant Lyra's figures, as quoted by the Rev. J. A. Zahm in his book, *Through South America's Southland,* they are, as a matter of fact, of less width than the latter, being 292 feet wide, though their height is 260. As it approaches the brink of the precipice the Papagaio breaks into heavy rapids, then plunges down into the ravine over a perfectly straight crest except for a jutting shelf of rock on the left-hand bank and some narrow channels on the right, which are separated by wooded islets from the main central fall. Father Zahm, who saw the falls after heavy rain in the full splendour of the morning sun, thus describes the effect:

"From the abyss below came the roar of incessant, slightly modulated thunder which kept rock and earth in continuous vibration. In the shattered crystal masses of the deep and narrow gorge which hemmed in the river below the cataract, in the lingering eddies, in the translucent rush near the banks, in the shimmering spray, in the wreaths of ascending mist, there was a play of colour, from the light chrysoprase to deep amethyst, that was a continual delight to the eye and a stimulus to the imagination. Surmounting the flashing mass of foam in the abysmal depths, and giving life and colour to the opalescent vapour that ever ascended heavenward from the seething torrent below, was an exquisite iris, alternately fading and flushing in the surging clouds and the shivered sunbeams. It was indeed a gorgeous spectacle and, accompanied by the deep, resonant diapason of the rushing waters, its effect on the mind was like that of a tumultuous lyric or a Wagnerian symphony."

In the State of Goyaz, de Mello mentions two falls on the Rio das Almas, a tributary of the Tocantins ; the upper one of which he states to have a drop of 108 feet, and the lower 216 feet. A view I have seen of the latter fall shows an immense natural bridge of rock below the cataract which the waters have eroded. In the same state on the Rio Preto, a tributary of the Rio Maranhao, there is a still higher fall of 250 feet. Unfortunately I have not been able to obtain any authentic details as regards either of these three falls.

As regards the northern affluents of the Amazon, Dr. Hamilton Rice, the well-known explorer, has described a formidable fall on the Uraricuera River during his expedition in that region in 1924–25. This stream is a western affluent of the Rio Branco which pours into the Rio Negro, the latter in turn being the main northern tributary of the Amazon. The falls which are named Purumame consist, apparently, of three successive leaps, and though the highest drops no more than 95 feet, they are of considerable volume. They occur on the north " furo " of the river, that is to say, on a narrow channel connecting two sheets of water, and at a point where it splits into two divisions, enclosing between them the island of Maraca.

Dr. Rice describes it as the largest fall in Brazilian Guayana, and as an impressively wild and beautiful cataract. The whole of the descent, he states, is hemmed in by a great gorge that accentuates the roar of the waters, " making an impressive and inspiring spectacle stupendous in mass and volume." He adds that these falls are a sort of shrine or oracle to the neighbouring river Indians and that the latter practise propitiatory rites when visiting them. This is no doubt the same fall which de Mello mentions as occurring on the Uraricuera under the name of the Grande Cachoeira.

But perhaps one of the finest falls on any northern tributary of the Amazon is the fall of Agoyan in Ecuador, where at a height of over 5000 feet above sea-level the great Pastaza River breaks through the Cordillera in a deep valley on its way to the plains. In this part of its course it is called the Agoyan River, and hence the name of the falls. At the point where its leap of close on 200 feet occurs, the Pastaza has already received many considerable affluents, and it shoots down between tremendous precipices, sending aloft clouds of white foam, and descending through its deeply cut channel with immense force. This is generally considered to be the largest fall in the Ecuadorean Oriente. Blair Niles, in her *Casual Wanderings in Ecuador*, thus writes of it as she viewed it from the trail high above it :

" We always wanted to remember the lofty embracing hills, green and deserted, and the insignificant trail upon which we stood in the high mountains, with Agoyan frothy white below us. Agoyan provides no power to turn wheels of commerce. No hotel-keepers or postcard vendors make capital from its loveliness. As we stood gazing down upon it, with nowhere any sign or trace of man other than the rough trail he follows, I felt myself to be looking upon a beauty which exists solely for the priceless sake of beauty, without sordid or ulterior motive, without consciousness of itself, and therefore independent of applause. In their lonely loveliness the falls of Agoyan scorn variety and display. They are that undefiled beauty which justifies Stendhal's definition. They are indeed *une promesse de bonheur*."

The falls are situated a little below the small town of Banos, and not far from the beautiful volcanic cone of Tungurahua. A short distance below them the falls of La Merced are formed on one of the Pastaza's tributaries and plunge down into the parent stream over a verdant cliff. Mr. Reginald Enoch tells us that the ancient name of the Pastaza was the Sumatara ; and after speaking of the immense volume of water at the falls, which becomes transformed into white foam, he observes that their site is one of the most picturesque places in the Andes, " its appearance being heightened by the vegetation, which, at this elevation of 5120 feet, takes on a tropical character."

While on Ecuadorean soil, we may mention two other falls

Plate [illegible]

[illegible] THE CHARITY FALLS, RIO PAPAGAIO, BRAZIL

[illegible] THE FALLS ON THE LAJA RIVER, CHILE. (See page [illegible].)

[illegible] Pan American

which are still very little known outside that country. One of these bears the odd name of the fall of the Excomulgado, or the Excommunicated One ; the story being that in the early days of the evangelisation which followed the Conquest, a Spanish priest on whom some ecclesiastical anathema had weighed heavily, threw himself in despair into the abyss into which the water plunges, and was no more seen nor heard of. This Salto del Excomulgado, which is near the boundary separating Ecuador and Colombia, somewhat resembles in its forbidding surroundings that of Maletsunyane in Basutoland, though it is not nearly as high.

According to M. Edouard André these falls are one of a number of cascades which have been caused by a volcanic or seismic rupture of the high plateau of Ipiales. The water descends through thick woodlands, first separating into different channels and then, after collecting together again, pouring down in a single leap of some 262 feet into a deep pit at the foot of a perpendicular wall of rock, where it has hollowed a great trough shaped like a gigantic shell. The leap is singularly straight in form from top to bottom, and the neighbouring rocks, eroded and worn by the force of the torrent and piled up on one another into the most fantastic shapes by the cataclysm which so suddenly changed the level of the river-bed, are of the most varied and bizarre colours.

M. André mentions another series of falls in the same region on the Sapuyes River which descends near the hacienda of Cuarchu with tremendous force over 4065 feet within a distance of about 6¼ miles, one plunge alone being over 980 feet. It is this river which drains the basin of the lake of Pastos which formerly had an area of more than 231 square miles ; and it is also noteworthy for the fact that near the pueblo of Cumbal it is spanned by the well-known natural bridge of Rumichaca, which was at one time mistakenly supposed to have been the handiwork of the Incas.

The other Ecuadorean waterfall of note is that of Napa not far from Quito. This is another instance of a fall, or rather, a series of falls, which pours down over the rocky face of a vast amphitheatre in the mountains, the wall of which rises sheer for from 1000 to 1300 feet. M. Charles Wiener has described Napa as being of an imposing beauty and consisting of a succession of four separate falls with an aggregate drop of nearly 1000 feet. At the top of each plunge the stream has the appearance of a broad white ribbon which dissolves as it shoots downwards into fine crystalline dust. At the foot of each drop the torrent collects into natural rock basins, whence it again takes a further leap. M. Wiener compared the black cliff as seen through the transparencies of the falling water to the glistening skin of a negress under a white veil.

Along the eastern slopes of the mighty Andes there are doubtless an immense number of fine waterfalls which are practically unknown and scarcely named, but before turning to Ecuador's neighbour, Colombia, and giving some account of the latter's chief river wonder, Tequendama, we must cross for a moment to the Pacific side of the Andes to glance at what has sometimes been named the Niagara of Chili. This is the well-known fall of the Laja River, the main branch of the Bio-Bio which enters the sea near Conception and which is the largest stream of the south-west coast. The Laja here plunges down in a double fall between steep walls of volcanic rock, dropping, it is said, about 106 feet. The volume is considerable.

For a long time past schemes have been discussed for the harnessing of these falls, but I have been told that, hitherto, nothing has been done in the matter. The Laja has its source in the snows of the volcano of Antuco, though, strange to say, its waters are so dark that they have been described as "inky." This is owing to the immense quantities of black sand it brings down, which are so great that they obstruct the course of the wide but shallow Bio-Bio below the confluence. The course of the Laja is about 60 miles and the falls occur some 18 miles above its mouth. M. J. de Cordemoy mentions the curious fact that the Laja (*La* Laja) is alone among rivers with Spanish names in being designated by the feminine gender. Other fine Chilean Falls that may be noted are those of Pilmaiquien.

To turn now to Colombia, the very name of Tequendama, the famous waterfall on the Funza River, situated some 20 miles south-west from Bogota the capital, has a magical sound which well accords with the ancient Chibcha legend of its supernatural origin. It is a legend which has often been recounted and which centred around the noted and sacred lake of Guatabita, a name which was also given to one of the five states into which the district of Chibcha was divided up prior to the first arrival of the Spaniards into the country. One of the best and most concise versions of the story has been given by Professor Konrad Haebler in Helmolt's *World's History*.

"Guatabita," he writes, "formed the oldest religious centre of the whole area of Chibcha population. Here, on the lake of Guatabita tradition placed all those events of the past which served to explain the conditions of the present. Here in particular was placed the battle between the mythological hero of the Chibchas, Bochica, who was certainly an incarnation of the sun, and his wife Chia, an incarnation of the moon, who was as wicked as she was beautiful.

According to tradition, the Chibchas, at their first appearance, were mere savages living in the valley of the Funza River, which was then entirely surrounded by mountains upon the south. Bochica came to bring them the blessings of civilisation ; he taught them how to cultivate the maize and potato, to make them garments by spinning yarn, and to live as an organised community. But Chia everywhere opposed his efforts towards civilisation, and when she saw that in spite of her energy the work of Bochica became more and more successful, she dammed up the outflow of the Funza until its waters filled up the whole valley, and only a few of the inhabitants succeeded in escaping to the highest peaks. Thereupon anger overcame Bochica. He banished Chia from the earth, and put her into the heavens as the moon ; then with his lightning he split the enclosing valley wall, so that the waters rushed out in the mighty waterfall of Tequendama, and only the lake of Guatabita remained as a memorial of the universal flood."

It is said that the Chibchas used to offer sacrifices to Bochica at Tequendama in gratitude at his having saved them from the deluge by this blow of his magic wand ; an act which a French traveller, Dr. Saffray, has compared to that of the ancient Thessalians who used, in a like manner, each year to thank Neptune for having opened a passage for the River Peneus between Mounts Pelion and Ossa. Be that as it may, the lake of Guatabita itself became especially sacred and for innumerable years was the scene of immensely valuable offerings. At the time of the coronation of a new Chibcha chief, the latter was smeared all over with a kind of sticky earth and then powdered with gold dust ; after which, accompanied by four other Caciques all arrayed in gorgeous garments, he was rowed out to the centre of the lake in a boat which had previously been laden with gold and emeralds, and there he cast in these rich offerings to the gods who were supposed to inhabit its depths. Hence arose the legend of El Dorado, or the Golden Man.

Several attempts, indeed, have been made in modern times to drain the lake and to recover its hidden treasures, but with indifferent success. That an immense booty lies awaiting the fortunate finder seems extremely probable, as even from the shallower parts near the shores, where the poorer classes cast in their gifts, gold to the value of many thousands of pounds has been recovered.

Dr. A. C. Veatch, F.R.G.S., in his interesting book *From Quito to Bogota*, observes of this legend of the valley of the Funza having formerly been a great lake that it "rests on a solid basis of fact easily demonstrated, that there was a period in which there was a Sabana fit for the habitation of man followed by a period when the outlet was dammed by glacial action and the area converted into a lake, and that this was finally drained by the formation of the channel along which the Rio Funza or Bogota now flows. Does this legend," he asks, "represent only a deduction or is it a record of an occurrence actually witnessed by the ancestors of the Chibchas? I am inclined to favour the latter hypothesis, and to regard it as placing the beginning of the Chibchas at a very remote date."

Like that of Kaieteur, the fall of Tequendama plunges down into an amphitheatre-shaped pit which, though of less depth, is perhaps even more beautiful by reason of the contrasting colours of the brilliant vegetation that clothes its sides and floor. M. Dubois writes: "As you stand on the brink of the precipice over which the waters plunge, you are in a temperate climate, surrounded by the plant life of the temperate zone. When the water strikes the bottom of the great chasm, it finds itself surrounded by a dense tropical growth. The scenic setting of the falls of Tequendama makes them the queen of all waterfalls."

The cliffs of this vast oval hollow, which narrows abruptly at the bottom, are blue and grey, rose and pale yellow. They are hung with vines and a variety of flowering shrubs; begonias, the podostemon and the gunnera with its enormous leaves among others. Above the falls the stream, which may be compared in size to a large Scotch salmon river, descends after traversing a sandy plain through an upper gorge which gradually narrows, and whose bed is strewn with immense boulders. Over these the torrent pours in a succession of cascades, and at one point makes an upper fall of approximately 147 feet, which has been harnessed since 1900 by the Compania de Energia to supply electricity to Bogota. It may here be mentioned that Tequendama itself has so far escaped that indignity, and being regarded with considerable

Photo by courtesy of Mr. [illegible]

THE FALLS OF TEQUENDAMA
Height, 445 feet.

pride by the Colombians may possibly continue to remain exempt from spoliation.

The sides of the ravine, which extends from 3 to 4 miles and averages some 50 feet in width, are bedecked with an immense variety of plants and flowers of the most brilliant hues. The torrent seems to rush forward with ever greater speed as it approaches the precipice. Here, at the crest, it has worn a great groove in the sandstone table over which it pours. It first shoots down and out for about 25 feet on to a projecting rocky ledge, from which it again bounds off in a single sheer leap into the abyss below, forming a thundering column 50 feet in thickness and expanding to 150 in breadth, which has been compared when lit up by the sun's rays to a stream of molten gold. The accompanying view of the cataract, for which I am indebted to Mr. Kenneth G. Grubb, conveys an unusually good idea of it.

The height of Tequendama has been measured a number of times, but with widely different results. The celebrated traveller von Humboldt gave two estimates, one of over 578 feet and the other of approximately 600 feet. These, however, have now been found to be much exaggerated, and the height usually assigned to the fall to-day is 443 feet, though I have seen it stated that Dr. Hamilton Rice, after very careful measurements, made it no more than 410 feet.

Before turning to the eastern river basins of the continent, one should mention as a further Colombian curiosity the falls on the Rio Vinaigre or the Rio Pusambio, a tributary of the Cauca and therefore, like Tequendama, belonging to the Magdalena basin. The stream derives its first-mentioned name from the fact that its waters contain so great a percentage of sulphuric and chlorhydric acids that no fish can live in them, and it is said that one finds none either in the Cauca for a distance of 5 leagues from the point where the Pusambio enters it. There are three falls of varying heights, the greatest of which drops nearly 400 feet.

Turning to the eastern and north-eastern river basins of the continent one finds perhaps the most formidable waterfall of all, after the giants described in previous chapters, on the Jequitinhonha River, or, as it is also named in its lower course, the Rio Belmonte. The manner in which so many of the South American rivers, by the way, are given different names in different parts of their courses is not a little confusing. This fall, or rather, succession of falls, on the Jequitinhonha might well, indeed, almost be included among the giant falls. It has sometimes been described as a smaller edition of Paulo Affonso, but unfortunately I have not been able to find any reliable modern account of it.

The river, which is said to have a length of some 670 miles, rises in the state of Minas Geraes not far from Diamantina, whence it flows through that of Bahia into the Atlantic; and the falls occur not far from the point where it crosses the boundary line between the two states. Paul Walle in his *Au Brésil—du Rio São Francisco à l' Amazone* says that the main fall, known as the Salto Grande, has a height of over 144 feet and comes down with a noise like thunder.

Agassiz says of it: "At the Salto the river reaches a point whence, within the distance of a mile or thereabouts, it descends some 300 feet, more or less, in a splendid series of cascades and rapids. At the head of the Caxoeira, when the river is not swollen, it is suddenly narrowed to 40 or 50 feet, and plunges down a very steep incline into a gorge with perpendicular banks, making a wild and most romantic fall of about 50 feet. Below this are other falls which, owing to the state of the weather, I was unable to visit. On each side of the rapids is a wide strip of rocky ledges, swept bare. When the enchente prevails, the stream swells too big for its channel, and pours in a terrific flood over the rocks on each side, making a series of rapids to which those of Niagara are as nothing. The Salto Grande during the floods must be a sight worth a pilgrimage to see. The *Diccionario Geografico* says that the fall is 20 bracas in height, and that the noise of the water may be heard at a distance of 4 leagues, which is not very correct. The Salto consists of several falls and rapids as above described."

In a note with reference to their height, he adds: "I am entirely unable from the character of the country to form a very reliable estimate of the total height of these falls, but I believe that 300 feet is much within the truth."

Baron Homem de Mello states that the chief falls are four in number, namely, the Cachoeira do Salto Grande, the Inferno, the Torrinha and the Angelim. The width of the river below them is from 800 to 1000 feet and more.

The Jequitinhonha has also been called "The Diamond River," for it is along its banks and those of certain of its left-hand tributaries, such as the Ribeirao do Inferno, the Rio Caethe, etc., that there are found some of the most productive diamond-bearing deposits in all Brazil. These are all alluvial and surface deposits, involving no deep mining as in South Africa, and consequently the gems can easily be extracted by means of hydraulic and dredging apparatus. Several of these dredges, the scows of which are built of valuable native timber, have long been in operation, and each can handle a thousand cubic yards of " dirt " per day at a cost of approximately 30 cents per yard.

Next to that of the Rio São Francisco, the Jequitinhonha has probably the largest of the eastern river basins of Brazil.

Proceeding further south to the state of Santa Catharina, de Mello mentions an unusually high fall, which he calls the Salto do Pilao, on the Itajahy River. He assigns to it a drop of no less than 524 metres, or over 1719 feet, but he gives no particulars and does not state whether it consists of but one or several leaps.

For a final example of a fine fall near the eastern coast, the falls of Herval may be mentioned which are situated near Sapyranga, about 10 miles north of the line connecting Porto Alegre with Taquara, and which are so named after the small neighbouring village of Herval. The water shoots out in considerable volume from a cleft in the precipice and plunges down into a gloomy pit for a sheer 400 feet. It has been described as " a shower of molten silver falling into a cauldron of pitch." With such force does the torrent hurl itself out from the rock wall that it is possible to walk along a ledge behind it and to look through it far down into the black abyss below. A project has long been under consideration to harness this fall to supply electrical power to the district between Porto Alegre and Taquara, and by this time it has very probably been shorn of its glory in consequence.

Proceeding northwards to the north-eastern basins, de Mello refers to several falls on the Rio Oyapock which forms the eastern boundary of French Guiana. Thus he mentions the Salto Robinson, the Salto do Aouani, the Salto do Canoa and the Salto do Manoa, to the latter of which he assigns a drop of over 344 feet. As far, however, as the latter fall is concerned, I think he must be mistaken. There is no mention of it at all in the work of Jules Creveaux, who explored the whole course of the Oyapock, as well as the courses of the Rouapir, the Kou, the Yary, the Parou, the Ica and the Yapura, all in the same region, during the years 1877 to 1879.

Creveaux merely mentions the name Manoa as being that of a small rock which was so called after an old Indian who was drowned near-by. He himself, by the way, was murdered by some Toba Indians on a later expedition in the neighbourhood of Paraguay. The only fall of any account which he mentions on the Oyapock is that of the "Trois Sauts," where the river descends over three great steps for an aggregate drop of about 65 feet, and not far above the Manoa rock. He also mentions two other falls of approximately the same height on the Rio Parou and the Rio Yary respectively. The first of these he names the Chute de Panama, while the one on the Yary he calls the Chute de Pancada. In the middle of the crest of the latter, he describes two gigantic isolated rocks which tower aloft like the columns of some ancient Egyptian temple.

The most important fall he appears to have come across, however, is that of the Araraquara on the Rio Yapura where that river has cut its way through an immense rampart of sandstone. Above the falls, he says, the river measured from nearly 800 to 900 yards in width, but presently it acquired tremendous speed as it penetrated a defile only 60 yards broad, the sides of which were composed of white rocks split lengthways and crossways like walls raised by giants. At the further end of this rift, down which the river surged with ever-increasing momentum for about 1000 yards, it plunged into an abyss close on 100 feet deep, from which it rushed out again making great waves like those of a raging sea.

Finally we must return again to British Guiana, where it is the extraordinary mountain of Roraima and that of its immediate neighbour, Kukenam, close to the colony's western boundary and in territory that might be claimed as well either by Venezuela or Brazil, which produces some of the most noted falls in all South America on account of their extraordinary heights. Some of these, indeed, may quite possibly be the highest on the globe, though that distinction is popularly accorded to the great falls in the Yosemite Valley, California, which have a total drop from their crest to the valley floor of 2565 feet, the upper leap alone being a sheer 1430 feet. As a matter of fact, by the way, as we shall see later, the single leap of the Ribbon fall in the same valley is still greater than the highest of the latter, being 1612 feet, though the volume is extremely slight.

While on the subject of very high falls and the difficulty of being definitely able to assert that any particular fall has the distinction of being the world's highest, it may be as well to state here that the height of a waterfall is a very elastic term. While to a tourist it means the height of the conspicuous, more or less vertical part of the fall, to an engineer it means the height of that part which lends itself to development for power and which is usually known as the " head " of the fall. This is a point we shall have to refer to again when we come to discuss some of the best-known Scandinavian waterfalls ; one may merely observe here that, generally speaking, the " head " of a fall is considerably greater than the "scenic" drop which it presents to the spectator.

The once mysterious Roraima which, it may be recalled, inspired the late Sir Conan Doyle's well-known romance, *The Lost Continent*, was well named by the Indians " The ever-fruitful Mother of Streams," for, together with Mount Kukenam, it forms the watershed of several tributaries of the three great river systems of the Amazon, the Orinoco and the Essequibo, of which latter, as we have seen, the Potaro River on which the Kaieteur Falls are situated is also an affluent. Both mountains lie roughly parallel to each other, separated only by a deep and narrow valley. As their greatest lengths, which run from north to south, extend from some 10 to 12 miles, it will be gathered that their seemingly flat summits have a considerable area. They were first seen at a distance by the brothers Richard and Robert Schomburgk in 1838, but it was not until forty-six years later that Roraima was climbed.

Sir Robert Schomburgk related that the Indians had a legend that the summit of the mighty sandstone ramparts of Roraima could never be reached by human beings, and that it contained large lakes " full of remarkable fish-like dolphins, and continually encircled by gigantic white eagles—their eternal warders."

J. W. Boddham-Whetham further records another Indian superstition, namely, that the mountain was guarded by an enormous " camoodi " capable of entwining a hundred persons in its folds, and that a native who once approached its den had seen " demons running about as numerous as quails."

In December, 1884, however, the top of Roraima was at length attained by the late Sir Everard (then Mr.) im Thurn, accompanied by Mr. H. I. Perkins, an assistant Crown Surveyor. They gained the summit by following a ledge, up to then thought to be impracticable, that ran diagonally up the face of the cliff and at one point actually passed under one of the falls. The plateau on which they emerged presented a scene of the most extraordinary description, being covered with piles of rocks of the most varied and grotesque shapes, heaped up on one another in fantastic confusion. Some of these strange pinnacles were 80 feet in height.

The plateau itself, which had appeared from below to be perfectly flat, was found to consist, generally speaking, of a vast shallow depression or basin, its boundaries being formed by the actual rugged edges of the cliff. This again was divided up into a great number of smaller and very shallow basins, separated by curiously terraced ridges of rock. These basins were full of water fed by innumerable streamlets and tiny waterfalls which poured over pure yellow sand among the rock masses from one to the other, and which owed their origin to the clouds which are constantly resting on the mountain's summit and depositing there their moisture. From the basins, again, numerous channels diverged at right angles to the edges of the cliff, and it was through these that the water was conducted to plunge down over the great precipices, thus forming the many falls which streak the sides of Roraima. The surface of Kukenam, which was at a rather lower elevation, appeared to be of much the same kind of formation.

Of the falls themselves, Richard Schomburgk has given the earliest account as he viewed them at a distance in his *Travels in British Guiana* (1840-1844). "Innumerable waterfalls," he writes, "rush in continual procession down from the flat summits (i.e. of Roraima and Kukenam), and the most brilliant description will always remain but a shadow to the truly imposing sublime Reality, with the thundering and foaming cataracts, with the wonderfully enchanting tropical vegetation at their base."

The same traveller, by the way, on his journey to Roraima, also saw and described the falls of the Rue, a tributary of the Kukenam River, which have a principal drop of 120 feet, followed by no less than sixteen further cascades varying in height from 4 to 40 feet, and pouring down over red and rosy ledges of jasper.

C. Barrington Brown, the discoverer of Kaieteur, also writes as follows of a distant view of Roraima from the upper Marazuni River:

"Upon the side of Roraima I saw an enormously high waterfall, looking like a white thread against the dark-blue mountain. The Indians said that it was the head of a branch of the Cotinga River; but I afterwards learnt from an intelligent Arecuna that it was the head of the Caroni River, a branch of the Orinoco. It is probably the highest fall in the world, and at the same time of considerable width. The vertical portion of Roraima is 2000 feet in height, over the upper half of which it fell like a plumb-line and then descended with a slight slope outwards. The remaining 3000 feet to the valley below slopes at an angle of 45 degrees, and, being tree-covered, the rest of the fall is hidden by foliage."

And again he writes in another passage :

" When viewing it from a mountain on the upper Marazuni, in 1872, at a distance of 30 miles, I distinctly saw an enormous waterfall, on its north-eastern side, of very considerable width and extraordinary height."

The above figures would make the aggregate height of this fall in the neighbourhood of 5000 feet. As I have already mentioned, the Caroni River, to which Barrington Brown here alludes, has another formidable fall not far above the point where it joins the Orinoco, though of course of far less height.

J. W. Boddham-Whetham, on the other hand, says that the fall which is the head of the Caroni River falls over the ramparts of the Kukenam mountain and not over Roraima. " From this mountain, too," he writes (i.e. Kukenam), " a splendid waterfall makes a clear leap of 1500 feet before it disappears in the green wilderness at its base. It issues from the forest as the Kukenam River, and after joining the Yuruarti, which also rises in the Kukenam mountain, forms the Caroni River, which flows into the Orinoco below Cuidad Bolivar."

As regards Roraima, he mentions first three waterfalls which descended " like skeins of floss silk swaying in the wind," to lose themselves in the woods below ; and then, towards its northern end, he speaks further of a " magnificent cascade, whose lip seemed to be below the summit," and which " sprang in a broad silvery arch right down into the green depths, barely touching the rocky wall in its descent."

This latter fall, he says, is the source of the Cotinga River, which eventually falls into the Amazon after mingling with the Rio Branco and the Rio Negro. Yet further north again, he mentions another fall which went to form one of the chief tributaries of the Cako River.

The way in which the lip of the above-mentioned fall appeared to be below the summit is explained by Sir Everard im Thurn, who tells us that the channels leading from the basins to the edges of the precipice are often cut more or less deeply into the rock, so that the water shoots out below the actual crest of the ramparts. These channels, moreover, are concealed from a spectator stationed below the mountain.

The volumes of these various falls which pour down from the summits of Roraima and Kukenam no doubt shrink a great deal in the dry seasons and dwindle to very slight proportions, but as the annual rainfall is well over 100 inches, their mass may well be very considerable at the height of the rains. This increase in volume is also very rapid.

Sir Everard im Thurn, for instance, mentions that after his descent from the mountain a day or two's rain produced eight further cascades pouring down the face of Roraima alone, apart from others on Kukenam. Nor are the widths of some of these falls by any means negligible in flood time. The fall, for example, under which Sir Everard had to pass on his way up the ledge to the summit of Roraima, extended, he says, for 150 yards, falling from some 2000 feet above him ; and though at that time the volume was so slight as to be dissipated into the semblance of heavy rain, it would no doubt have proved quite an impassable obstacle had it been in spate.

We may mention here two other falls in British Guiana noted by Barrington Brown, namely, those of Orindouie on the Ireng River, 56 yards wide and 213 feet high, and the still more imposing falls of Sericoeng on the upper Marazuni, " where the whole of the water of the Marazuni was precipitated over three steps, the last being more than 100 feet high, into a large, almost circular basin bounded by high cliffs."

More recently, in 1934, the discovery of a new and imposing fall on the Upper Essequibo has been announced, but, except that it is said to be horse-shoe shaped, details are so far lacking.

We will here take our leave of the South American waterfalls, though there are many others which might be mentioned had we unlimited space at our disposal. The chief characteristic of the falls of this continent, as compared with those elsewhere, is their greater average volume. South America, as we have seen, boasts the fall of the greatest volume in the world in that of Guayra, the widest and most extensive[1] in those of Guayra and Iguazu, the fall that has the greatest mass of any single undivided fall in the world in Paulo Affonso during its flood period and, most probably, the falls having the highest single unbroken leaps among those which plunge down from the summits of Roraima and of Kukenam.

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[1] As will be seen later, the total width of the Mekong at the Khon Cataracts, including a great many islands, is, according to Lieutenant Garnier, from 12 to 13 kilometres. Of this extent the chief falls on the Salaphe and Papheng branches of the river, would appear to occupy, in the aggregate, some 3000 yards, and possibly rather more.

CHAPTER VII

THE NORTH AMERICAN GIANTS : NIAGARA

THE books that have been written about Niagara Falls would fill the shelves of a small library. Their grandeur and beauty have been described by scores of world-famous writers, while as a chronometer of geological time they have been minutely surveyed by a number of eminent men whose names have shed lustre on that department of science. To attempt to say anything fresh about them, therefore, would seem a futile ambition. Yet there is a modern aspect of them regarding which a great deal can be said, and one which their old-time visitors, happily for themselves, were neither in a position to observe nor even to dream of. One wonders what such writers as Charles Dickens, William Dean Howells and others would feel or say were they able to see Niagara in its depleted condition to-day, and to compare its present deplorable attenuation at the hands of man with the magnificence they were privileged to gaze upon in their own time.

It is true that, given time enough—perhaps another 5000 or 10,000 years—Niagara would commit suicide on its own account, or at least would become so greatly altered as to be widely different from the Niagara we know to-day. It may even be true that its rate of recession back towards Lake Erie from which its waters emerge, a recession which averaged 4·2 feet per annum over the period 1842–1905, has been in some degree retarded in more recent years by the diversion of so much of its volume for power purposes, though such retardation is much more probably due to the increasing thickness of the limestone arch over which it now pours. To the specious claims of those who, incessantly agitating for yet greater diversion, have the effrontery to claim that by such means they are contributing to the falls' "preservation," it may pertinently be rejoined "but in what state?"

Mr. Samuel S. Wyer, a staunch advocate of the greatest possible diversion for power, in his pamphlet, *Niagara Falls : Its Power Possibilities and Preservation*, expresses the following extraordinary opinions :

"The height of the falls and not the volume of water is the controlling feature in the grandeur impression that is made on the spectator."

And again :

"The scenic grandeur aspect depends largely upon the awe in which the spectator is held and this sensation is stimulated much more by the uniform and continuous high, clearly visible sheet of water than by a mere wild, broken tumbling mass."

Let the reader here compare the view of the American Fall of Niagara, with that of the upper cascades of Paulo Affonso. I don't think he will be in any doubt as to which impresses him the most.

And once more :

" The greater beauty of the American Falls than of its Canadian neighbour arises from its unbroken crest, *generous* supply of a *thin* sheet of water, uniform distribution and clear vision because of the absence of spray. The Canadian Falls, although carrying much more water, create a less favourable impression than the American Falls. . . . The abnormal concentration of the water in the V-shaped notch, rather than its uniform distribution over the crest line, leaves many bare spots and gives the crest line a ragged appearance."

I have italicised two words in the above quotation. Incidentally, the " bare spots " were not to be seen before the water began to be diverted.

Absurd arguments of the same kind are being constantly put forward, for transparently obvious reasons which deceive no one, by the various power companies. Thus in a booklet entitled *The Lengthening of Niagara Falls,* issued under some of the latter's auspices, we read :

" . . . if the throat of the Horseshoe were one-tenth as deep as now, the backward march would be retarded. With a more moderate flow of water, the Horseshoe's grace would no longer be concealed behind a too-thick wall of mist. Instead, it would be shrouded with a veil of spray so dainty that it would enhance the cataract's splendour."

A model of the falls has even been made in which artificial islands and a series of under-water dams or weirs have been inserted above the Horseshoe Fall in order to show thereby how the water could be spread evenly along the latter's crest ; as regards which the booklet above mentioned remarks :

" It " (the model) " shows beyond a doubt that only 35 per cent of the outflow of the river is needed on the Horseshoe Falls to produce an even *greater* scenic effect than the present one."

These contentions are so ludicrous that comment seems almost needless. It is certainly *not* the height of Niagara that most impresses the spectator, except only as viewed when close under the falls and looking up from the deck of the *Maid of the Mist* in the pool below. Then, indeed, as one draws in along the base of the American Fall, or seems almost to be entering within the vast enfolding curtains of the Horseshoe, the eye, as it looks upwards and surveys those toppling crests, does get some impression of height. But seen anywhere from above, the height of the falls is entirely dwarfed by their great width ; and this struck me as particularly so in the case of the long, straight American Fall, with the piled-up talus at its foot, on my first distant view of it from the Canadian bank. Indeed it gave me the disappointing impression, from that view-point, of looking at merely an unusually high weir, to whose similitude and tame uniformity Mr. Wyer and others would apparently be well content to see both falls reduced.

No, the grandeur and the peculiar glory of Niagara, the Niagara, alas, that was, and the attribute which I affirm without hesitation most inspires awe and a sense of the sublime, is precisely its immense volume. It is there, in the heart of the Horseshoe crescent, in that deep curving mass of green water, partly curtained eternally by the spray-cloud from the depths beneath, that the mysterious spirit of the falls resides and ever beckons. It is there, too, that its immeasurably deep voice, of which Egene M. Thayer asserted that the chords of its different harmonies were four octaves lower than the keyboards of our pianos, and which he characterised as no roar but " the sublimest music on earth " and of a quality " divine," calls most loudly to those who have ears to hear it : that mass of water ever curving over majestically and plunging down, which yet conveys in its solidity an impression of god-like calm and repose. This effect has been noted and admirably described by William Dean Howells.

" But at times," he writes, " and if one looked steadily at any part of the cataract, the descending flood seemed to hang in arrest above the gulfs below. Those liquid steeps, those precipices of molten emerald, all broken and fissured with opal and crystal, seemed like heights of sure and firmest earth, and the mists that climbed them half-way were as still to the eye in their subtler sort. This effect of immobility is what gives its supreme beauty to Niagara, its repose. If there is agony there, it is the agony of Niobe, of the Laocoon. It moves the beholder, but itself it does not move."

It is obvious, then, seeing that its majestic volume is what makes Niagara the thing of wonder it is, that it is a mere mockery to pretend that large diversions of its flow will "preserve" it. Two very attenuated falls, or more probably only one, may still be left, but all that made the might and glory of the cataract will have vanished. Already, on the occasions of my various visits in 1906 and 1907, the American Fall, over which only about 6 per cent of the total volume flows, hardly anywhere exceeded 18 inches in depth at the brink, and in many places far less.

Some 800 feet of what is known as the Goat Island Shelf on that side of the Canadian Fall was already but thinly covered, and in places bare; while on the Canadian bank its width had been further curtailed by the building out of an artificial embankment for a distance of over 400 feet, on the specious pretence of extending and "improving" the International Park, but in reality to cloak the bareness of the cliff. The photograph of the Horseshoe Fall from the air will give the reader some idea of the depletion of the water, especially over the Goat Island Shelf, when compared with the other view of it before diversion.

Even at the time of my visit to Niagara, moreover, the amount of diversion was nothing like what it is to-day. The International Treaty limits the amount, for power purposes, to 56,000 cusecs in all, and, according to Mr. Adams in his book *Niagara Power*, diversion to such an amount has already been made. According to Mr. Wyer, who, as I have previously mentioned, reckons the total flow of Niagara to be no more than 205,000 cusecs, the aggregate quantity of water now diverted for all purposes is made up as follows:

	Cusecs
New Welland Ship Canal	2,000
New York State Barge Canal	1,200
Chicago Drainage Canal for Sewage Dilution .	8,000
Diversion, in all, for power purposes . .	56,000
Total	67,200

Mr. Wyer concedes that in order to sluice away the ice which collects in the winter, 5000 cusecs would be needed in the case of the American Fall, and a further 45,000 in the case of the Horseshoe or Canadian Fall, making 50,000 cusecs in all; and it is that amount which he considers would be sufficient to render the falls effective from a scenic point of view. This 50,000, added to the 67,200 already diverted, would make up 117,200 cusecs out of his total of 205,000, leaving a balance of 87,800 which he, of course, advocates should be additionally diverted for power. In

Photo by courtesy of the Ontario Government

NIAGARA: AN AIR VIEW OF THE HORSESHOE FALLS

Showing the recession in the centre and the present thinness of the water over the Goat Island Shelf.

other words, if his views were to prevail, over three-quarters of the natural volume of Niagara would, in one way or another, cease to go over the falls.

Long before anything like the above quantity was diverted, and supposing even a very moderate part of it was taken away above the rim of the First Cascade where the Upper Rapids commence, the American Fall would have ceased to exist, while the width of the Horseshoe, instead of being close on 1000 yards as it was in 1900, would probably be reduced to one-third of that, if as much. I might add that the International Treaty above mentioned which at present limits the diversion for power, apart from other purposes, to 56,000 cusecs, can be abrogated on either side by a year's notice, and that powerful monied interests are constantly agitating for further diversion. It has even been proposed to harness the famous Whirlpool Rapids below the falls, which would deprive Niagara of one of its most impressive features.

We are apt to regard the spoliation of Niagara as a purely American affair which but little concerns us, it being forgotten that the falls are very far from being the exclusive possession of the United States. In a letter to *The Times*, for instance, of February 12th, 1931, Mr. Owen Clough, C.M.G., who was attempting to show that the Victoria Falls had a volume, at certain stages, comparable to or even exceeding that of Niagara, quoted some figures in support of his contention, which he stated that he had obtained from the Southern Rhodesian Government "with the idea," as he expressed it, "of for once 'putting it across' our U.S. cousins." But his zeal was quite unnecessary in any event, seeing that the international boundary line passes within 235 feet of Goat Island, and that, therefore, almost the whole of the great Horseshoe Fall, over which 94 per cent of the total volume of Niagara pours, lies in British territory.

I shall deal with Mr. Clough's figures of the discharge at the Victoria Falls when I come to treat of them. I will only remark here that seeing that their true mean annual discharge, according to Dr. du Toit's figures, is well less than one-fifth of that of Niagara, the spoliation of the latter affords an instructive object-lesson of what may happen in the case of the Rhodesian marvel if its waters should be diverted for power to any considerable extent.

To revert to Niagara Falls, they should be regarded not as the exclusive property of any one nation, but as a unique world possession, which at all costs ought to be preserved to posterity, as far as may be, in its natural grandeur. Unfortunately the Canadian Power Companies appear to be even more impervious to the hideous effects of their activities than those of the United States. I have already mentioned how the Horseshoe Fall has had its crest line shortened by more than 400 feet by the artificial embankment on the Canadian side. A further unnecessary excrescence is the unsightly power-house of the Ontario Power Company which has been placed inside the Park Reservation, close under the cataract itself, and gives a glaring offence to the eye when viewed from the New York shore. Any idea of æsthetic values or ideals seems to be conspicuously lacking.

The falls, however, are not likely to be doomed to such an extent of attenuation as might be gathered from what has been said above for two reasons, which, fortunately, are powerful ones. First there are the financial interests which are concerned with the protection of navigation on Lake Erie and its harbours and canals, etc. As Professor Spencer has pointed out, the lowering of the level of the basin above the Upper Rapids, increasing the slope of the river and consequently the velocity of the current, also lowers the level of the lake; and he states that an increased discharge of 22,000 cusecs lowers Lake Erie by a foot. Already, in 1905, the canals and harbours were much shallower than they used to be, and there is, besides, a constant demand for deeper channels.

A second consideration which may give the Power Companies pause is the immense expenditure by visitors to the falls, which in some years, including transportation, has amounted to as much as 25,000,000 dollars. This will certainly decrease very appreciably should the falls ever be reduced to the state in which Mr. Wyer and others would like to see them, when, beyond a peradventure, they won't be any longer worth visiting.

Niagara, as I have already mentioned, differs from most other great falls in that its flow is fairly constant and is not annually subject to such great variations. The great lakes from which the river issues—some, indeed, have compared it to a strait connecting two inland seas rather than a river—act as a huge reservoir; and in them, also, is deposited the silt and other matter, the absence of which gives to the Niagara River that delightfully clear crystal green. Yet there are fluctuations, of course, caused mainly not by rain, but by the winds which blow

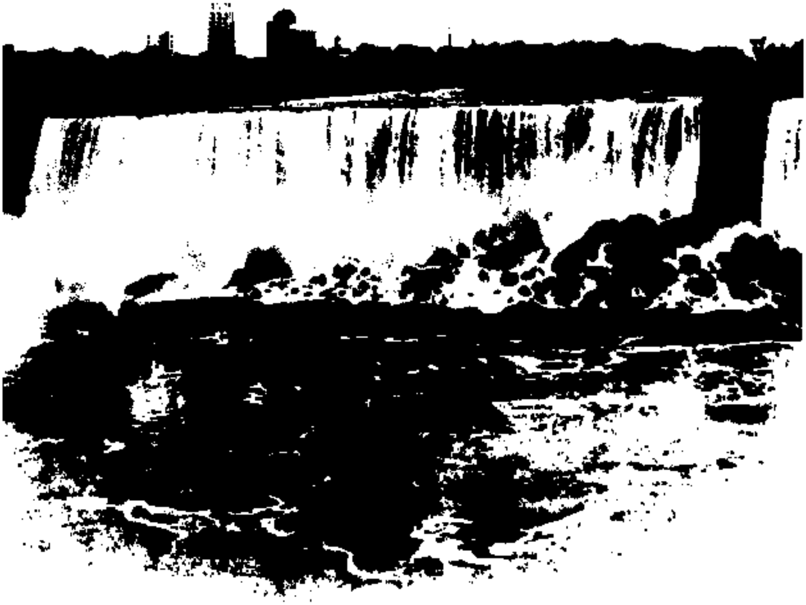
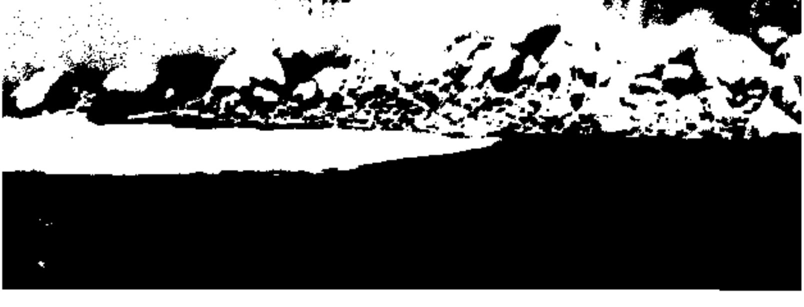


Photo. courtesy of the Dominion Water Power and Hydrometric Bur.

THE AMERICAN FALL, NIAGARA

Above, Before the rock fall of January, 1931. *Below*, After the rock fall of January, 1931.



down Lake Erie towards the falls, thus piling up the waters, or, *per contra,* blowing upstream and retarding them. Thus on October 7th, 1858, the flow rose to 292.000 cusecs, while on February 28th, 1902, it sank to 158,500.

It was in 1900 that the Niagara of our day attained to its supreme magnificence, the perimeter of the Horseshoe Fall being then 2950 feet, and that of the American, including the tiny Luna Island, 1000 feet. Thus, excluding Goat Island, the total width of Niagara Falls in its best natural state is, or was, close on 1316 yards, a figure to which we shall revert when we come to compare it in that respect with the Victoria Falls. Professor Spencer, who took the first soundings in the pool below as well as in the whirlpool, gives the following heights :

The Horseshoe, or Canadian Fall.

On the Canadian side	158 feet
On the Goat Island side	160 feet
At the apex in the centre	175 feet

The American Fall.

At its northern edge	167·5 feet
At Luna Island	169 feet

The superior height at the apex of the Horseshoe will probably surprise most people, but the Professor explains that it is due to the fact that the point in question is further up the rising bed of the channel and nearer its middle. In the Whirlpool a depth of 102 feet was recorded, and 126 feet nearer the bed of the river. In the pool below the falls soundings near the centre of the Horseshoe reached 69 and 72 feet, increasing to 84 feet at 1000 feet lower down, and to 192 near the head of the Whirlpool Rapids, the latter depth being 92 feet below the level of Lake Ontario.

So much for the salient details of Niagara's arithmetic.

History does not tell us the name of the first "Paleface" to gaze upon the great cataract. The earliest known allusion to it occurs in Samuel de Champlain's *Des Sauvages*, dated 1604, where he records what certain Indians on the St. Lawrence River had told him about it. It is not improbable that Champlain's interpreter, one Etienne Brulé, who later on had the untimely fate of being killed and eaten by the Iroquois, may have been the first to see it when he was in that neighbourhood about 1615, more than eighty years before Father Louis Hennepin published the first account of it in 1697 in his *Nouvelle Découverte d'un très grand*

Pays, but there is no proof of this. Hennepin himself saw the falls in 1678.

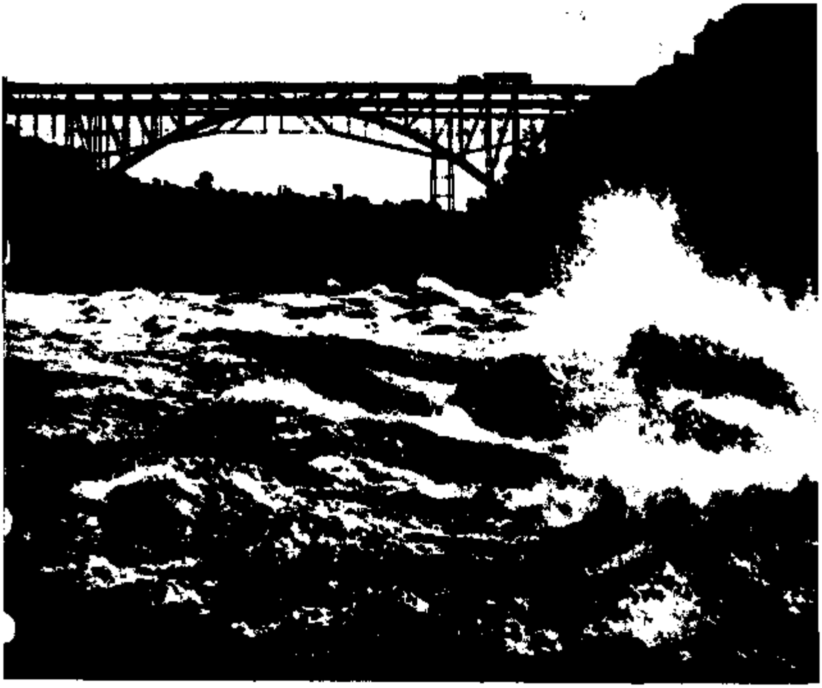
"Betwixt the Lakes Ontario and Erie," he writes, "there is a vast and prodigious Cadence of water which falls down after a surprising and astonishing manner, in so much that the Universe does not afford its Parallel. 'Tis true, Italy and Suedeland boast of some such things; but we may well say that they are but sorry Patterns when compared to this of which we now speak."

In subsequent accounts he greatly exaggerated the height of the falls; but nevertheless the print he gives of them is not so inaccurate as some might suppose, and it has now been proved that the third side-fall, which he depicts as descending from the neighbourhood of the old Table Rock, actually existed. The crest of the Horseshoe Fall in Hennepin's day was no more, so it has been reckoned, than 600 yards wide, and the falls have since receded about 300 yards.

Table Rock, by the way, which originally projected over the pool for about 60 feet, with a wooden staging a further 10 feet in length at its extremity, suddenly collapsed and fell in 1850. A certain Mr. Wilkes, accompanied by a lady, was the last person to walk upon it. The former noticed a new and ominous fissure across its base before they stepped on to it, but undeterred, they proceeded to its apex. There, fortunately for them, a sudden feeling of panic overtook them. They hurriedly ran back, and had not regained *terra firma* for more than a few minutes when the rock fell with a thundering report into the gulf; the sound, as Wilkes described it, being "like the explosion of an earthquake."

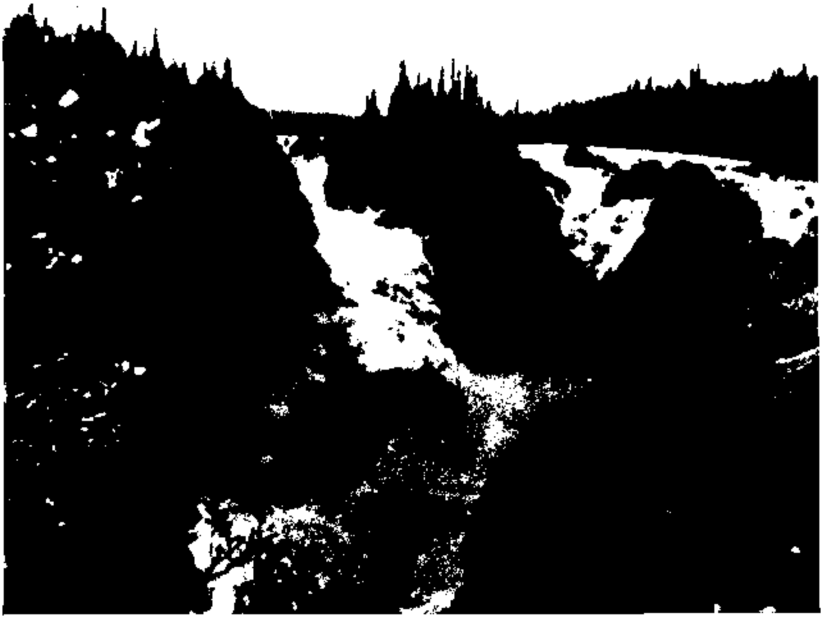
One of the greatest rock falls at Niagara in recent years took place in January, 1931, not, as one might have expected, at the brink of the Horseshoe Fall, but at that of the American, where the recession has been incomparably slower. This rock-slide, which was estimated at a thousand tons, made an indentation in the crest line of from 150 to 200 feet in width by about 150 in depth, and the piled-up débris at the foot of the fall was nearly 100 feet in height. I am much indebted to Mr. J. T. Johnston, Director of the Dominion Water Power and Hydrometric Bureau, Department of the Interior, Ottawa, for the two views of the American Fall, showing it both before and after the event. The reader will notice the extreme thinness of the water at the brink of the fall.

More recently still, namely, on August 13th, 1934, another rock fall of some thousands of tons occurred near Terrapin Point, on



Above: THE WHIRLPOOL RAPIDS, NIAGARA. *Below:* THE YALE FALLS, LABRADOR. See

Photo by the late Mr. Low



the Goat Island side of the Horseshoe Fall. One of the fallen blocks alone is said to have measured 30 by 60 feet. The correspondent of *The Times* reported that it was claimed that the effect of this rock fall was to enhance the beauty of the Horseshoe, the flow of water over the Goat Island Shelf being thereby increased.

Perhaps the most remarkable occurrence that ever took place in Niagara's history was when it went almost dry on the morning of March 31st, 1848. The cause was the blocking up of the river's exit from Lake Erie by the compression of floating ice which had been piled up there by a gale.

" . . . in the morning," writes Peter A. Porter, " the Niagara River as man knew it 'was not.' The American falls were dry. The Canadian falls were a mere shadow of their former selves, a few threads or streams of water only falling over the edge. People, fearful every moment of an onrush of water from upstream, walked in the channels, where, up to that time, the foot of man had never trod, and where it has never trod since. . . . All day this phenomenon lasted, but by night the sun's rays and the pressure of Lake Erie's waters had made inroads on the icy dam, and during the night the barrier was swept away. By the next morning the river again rushed by in its might, and its roar once more proclaimed that Niagara had resumed its sway."

It is recorded of a Mr. Street who, with his daughter, walked for some way out on the brink of the Horseshoe Fall on this occasion, that on looking down on to the pool below he saw the water so shallow that " immense jagged rocks stood up in such a frightful and picturesque manner that he shuddered when he thought of his having frequently passed over them in the little *Maid of the Mist*."

A similar occurrence, but on a smaller scale, took place on March 22nd, 1903, which, however, affected only the American Fall. Huge fields of ice lodged on the rocks and reefs between Goat Island and the New York shore, so that, again for one day only, the American channel was dry and the waters were all diverted to the Canadian Fall.

I was never fortunate enough to see Niagara in its enchanted winter garb when all the ice-encrusted trees and shrubbery glitter like a myriad jewels in the sunlight ; still less to see the ice-cone, sometimes attaining to 100 feet in height, below the American Fall, or the ice bridge which may form every four or five years or so. These latter features no other of our great falls, from their geographical positions, can ever provide, except possibly the

Grand Falls of iron-bound Labrador. Their superior height, however, and the consequent force and compression of the pent-up water falling into the cañon, probably prevents such formations.

I have no space to tell here of the various "Niagara Fools," as they have been termed, who for money or notoriety have either crossed the gorge on tight-ropes, have swum or navigated the tossing Whirlpool Rapids, or have dared the mighty plunge over the Horseshoe itself in barrels or other especially constructed spheres. These dare-devil feats are scarcely likely to be attempted in the case of other giant cataracts. The upper rapids of Paulo Affonso, for example, or the lower ones of Guayra, are mäelströms beside which those of Niagara are tame in comparison, and certainly do not lend themselves to anything of the kind.

I must confess, however, to getting a thrill during some talk I had with Mrs. Taylor, who, in October, 1901, was the first person to go over the falls. It was not, I may explain, Mrs. Taylor herself who inspired it. She was, indeed, somewhat deaf, as far as my memory serves me, and not very much inclined to talk of her experience which, doubtless, she was also tired of retailing. It was rather the sinister aspect of the barrel in which she accomplished the feat and which, when I saw her, was standing outside the little store where she then sold mocassins and Indian leather-work, etc., that gave me an involuntary shudder of apprehension as I tried to imagine how I myself might feel were I condemned to take a like trip in it. Its long, narrow, black and forbidding appearance was in some odd way decidedly reminiscent of a coffin, or so, at least, it struck me at the time.

Mrs. Taylor was said to have been forty-three years of age when she took the plunge. She was placed in the river above the Upper Rapids at 4·05 in the afternoon and was eventually picked up in the pool below the falls at 4·40. A part of the head of the barrel had to be sawn away to release her, which being done, she was seen to wave her hand to the assembled crowds who watched the event. If I remember rightly, she spent several weeks in hospital afterwards before she got over her experience.

The four most vivid impressions which still remain with me of Niagara are the vast sweep and breadth of the waters looking across the Upper Rapids from the Sister Islands to the Canadian shore ; the deep and sublime curve in the centre of the Horseshoe ; the leaping waves of the Whirlpool Rapids ; and the roar and the shock of the hurtling sleet, darkening the windy air, as one stood in the water-screened Cave of the Winds, or in the tunnel behind that vaster curtain of the Horseshoe, which, for all I know, may no longer exist to-day. I saw Niagara three times. Each time its spell grew and gathered the longer I remained. I would not care to look on it again to-day.

Niagara has been well called a geological chronometer. It is also a symbol of the impermanence of our so seemingly solid world. Its life history is but recent as we measure geological time. Professor Spencer, whose exhaustive survey of the falls and the gorge in 1905–6 afforded him much new data on which to base more accurate calculations, assigns 39,000 years to their age. At first, as he tells us, the Niagara River, fed by Lake Erie alone and with but 15 per cent of its present volume, poured directly into Lake Ontario in a low, wide fall of no more than 35 feet. Varying in height during the ages up to 240 and even 320 feet, it took 35,500 years to cut its way back over the first 3 miles of the present 7-mile gorge. Then, increased by the additional discharge of the other great lakes, its backward pace was greatly accelerated, and it took but another 3500 years for the remaining 4 miles of its journey.

Thus, it was not until tens of thousands of years after man first walked upon the earth that Niagara came into existence. Tens of thousands of years before he has disappeared, as far as we can see, its end will have preceded his. The day will inevitably dawn when the voice of its low thunder will be stilled; when that vision of mighty plunging waters so seemingly perdurable, hung with rainbows in the sunlight or white as wind-tossed snow beneath the moon, will no longer awe the heart of man, or, by the contemplation of their beauty, uplift his soul to some diviner height.

CHAPTER VIII

THE NORTH AMERICAN GIANTS: THE GRAND FALLS OF LABRADOR

THE Grand Falls on the Hamilton River in Labrador were first discovered in 1839 by a certain John McLean, an officer of the Hudson's Bay Company, who had been trying to find an inland route between two of that Company's Posts. It was while attempting to get from the interior by canoe to Esquimaux Bay that he came across the great cataract. He has left us a short account of the event in his *Notes of Twenty-five years' Service in the Hudson's Bay Territory*, which was published in 1849.

"We then," he writes, "proceeded gaily on our downward course without meeting any interruption, or experiencing any difficulty in finding our way; when, one evening, the roar of a mighty cataract burst upon our ears, warning us that danger was at hand. We soon reached the spot, which presented to us one of the grandest spectacles in the world, but put an end to all hopes of success in our enterprise. About six miles above the falls, the river suddenly contracts, from a width of about four hundred to six hundred yards, to about a hundred yards; then rushing along in a continuous foaming rapid, finally contracts to a breadth of about fifty yards, ere it precipitates itself over the rock which forms the fall; when, still roaring and foaming, it continues its maddened course for about a distance of thirty miles, pent up between walls of rock that rise sometimes to the height of three hundred feet on either side. This stupendous fall exceeds in height the falls of Niagara, but bears no comparison to that sublime object in any other respect, being nearly hidden from the view by the abrupt angle which the rocks form immediately beneath it. If not seen, however, it is felt; such is the extraordinary force with which it tumbles into the abyss underneath, that we felt the solid rock shake under our feet, as we stood two hundred feet above the gulf. A dense cloud of vapour, which can be seen at a great distance in clear weather, hangs over the spot."

It will be seen that, as in the case of Livingstone's first impressions of the dimensions of the Victoria Falls, McLean's figures scarcely do the cataract justice, its height being in reality over 300 feet, and the walls of the cañon rising to 500 and even 600 feet.

The next visitor, Joseph McPherson, who saw the falls twenty years later, left no account of them; and for a long time their existence was almost forgotten, except for occasional rumours which at length had the result of inducing Mr. H. G. Bryant and Professor C. A. Kenaston to make a trip to them in 1891. Oddly enough, in that same year another party of Americans, namely, the Bowdoin College Labrador Expedition, also started for the falls, but of four of their members who ascended the river only two reached their objective, and a little ahead of Mr. Bryant. The others were obliged to turn back owing to the upsetting of one of the boats and the consequent loss of provisions.

The successful pair, however, Messrs. Austin Cary and D. M. Cole, also discovered and partly explored the cañon below the cataract, whence it has come to be named Bowdoin Cañon. Owing to the spreading of their camp fire, they also subsequently lost their boat and outfit, and regained the coast only after great hardships. Labrador is emphatically not a country to travel in unless one is amply provisioned. Mr. Bryant in his account of the falls, which appeared in the *Century* magazine, speaks of there being no trace at all of bird or animal life in their vicinity.

Later, Professor A. P. Low, who made an extensive survey of a great part of Labrador during the years 1892–1895, also wrote an account of them in the *Annual Report of the Geological Survey of Canada* for the last mentioned year; while they have been visited more recently by the late Mr. Varick Frissell in 1925 and by the late Mr. H. G. Watkins in 1929. Since about the latter year, however, a service of tourist steamers has been in operation direct from Quebec and Montreal to stations on the south-east corner of Labrador, and Sir Wilfred Grenfell wrote in *The Times* of May 5th, 1934, that five commercial planes had been sent from the nearest hospital on the coast to the Grand Falls and back, the whole journey occupying no more than 5½ hours. Thus these remote and hitherto largely inaccessible falls will soon become far more widely visited.

The great distinguishing characteristic of the Grand Falls, which they share with the Aughrabies Falls on the Orange River, and perhaps in an even more marked degree, is the tremendous velocity of the water at the point of the take-off, by reason of the steep 100-foot slant of the river's bed down to the very brink of the actual vertical descent. The Hamilton River is the largest in Labrador, being some 600 miles in length from the source of its longest branch, and the great fall is about 250 miles up from its mouth.

Eight miles above the falls the stream widens into a lake-like expanse, and from the latter's exit down to the falls themselves, a distance of 5 miles, it descends over 200 feet in a succession of tremendous rapids. This descent, in its lower portion, may be compared to a V-shaped chute or funnel, the enclosing walls narrowing from 400 yards' distance apart to 50 at the actual brink of the cataract. The imprisoned waters gain increasing momentum as they speed wildly onwards, the last 300 yards being, according to Professor Low, "down a very steep grade where the combined waters rush in a swirling mass, thrown into enormous long surging waves, at least 20 feet from crest to hollow, the deafening noise of which completely drowns the heavy boom of the great falls immediately below."

Mr. Frissell says that as it nears the precipice the stream is actually thrown 30 feet higher against the eastern wall of its rocky trough by centrifugal acceleration gained from a sharp bend immediately above. At the crest of the fall, the water is first shot down an almost perpendicular incline of rock for about 100 feet, whence it shoots far out for a further 200 feet into a pool of 200 yards in diameter. "During this last drop," Mr. Frissell writes, "the huge mass of water is torn to shreds, and a great deal of it escapes in the form of vapour that can be seen twenty miles away." And he describes the basin into which the water plunges as being hidden by thick mists and darkness, through occasional rifts in which can be seen "a surface of boiling whirlpools, and waves 30 feet high dashing against the perpendicular walls."

Such, to give it its Indian name, is Patses-che-wan, meaning "the narrow place where the water falls."

The Indians, so Mr. Bryant tells us, have a legend that two maidens who were once swept over the falls have since dwelt at their foot in the space between the far-flung curtain of water and the cliff behind it, where they have passed the years in preparing and dressing deer-skins. No longer young, they "can be seen betimes through the mist, trailing their white hair behind them and stretching out shrivelled arms towards any mortal who ventures to visit the confines of their mystic dwelling-place."

The exit from the basin at the foot of the falls lies at right angles to them, and takes the form of a very sharply cut cañon which winds and twists for several miles till it opens out into the lower river valley. This cañon, cut into solid gneiss and granite, rarely exceeds 100 yards in width at its summit or a third as much at water level. In traversing it, the river falls a further 260 feet,

Photo by the late Mr. Varick Frissell, by courtesy of Dr. Lewis Fox Frissell

THE GRAND FALLS ON THE HAMILTON RIVER, LABRADOR

but without any great individual drop. Thus, in a distance of from 12 to 13 miles, from the lake-like expanse 5 miles above the falls to the cañon's exit, there is a total descent of 760 feet.

The Grand Falls are justly reckoned to be among the great falls of the world, though no more than 50 yards in width at the brink as compared with the far greater extent of Niagara, the Victoria or the Iguazu Falls. Neither of the latter can show at any one point such velocity combined with concentrated mass as can be witnessed here; and though the volume in the centre of the Horseshoe at Niagara is, of course, very much greater, the speed and force of the rapids immediately above the brink of the latter are not nearly as great or awe-inspiring, apart from the fact that the height is far less.

Mr. Bryant, who measured the latter at Grand Falls with a weighted line, found the actual leap to be 316 feet, and the vertical height of the sloping, almost perpendicular chute above it to be a further 32 feet, making a total drop of 348 feet. Professor Low, however, makes the drop to be 302 feet; presumably of the actual leap apart from the chute. From Mr. Frissell's observations it would seem that the falls are cutting their way back very rapidly, as he records that at the time of his visit in 1925 it would have been quite impossible to drop a plumb line out beyond the sloping cliff to the bottom of the falls as Mr. Bryant had been able to do some thirty-five years earlier. The crest, in other words, has become still more sloping, a fact on which Mr. Bryant himself commented when he saw Mr. Frissell's photographs.

As regards volume, no actual measurements, as far as I am aware, have yet been taken. Mr. Bryant spoke of " an immense volume of water " shooting over the falls, though he says the river was then as low as it probably ever gets, and he noticed débris left by the spring freshets at least 10 feet up on the banks. Professor Low estimated it at a minimum of 50,000 cusecs, but I cannot find that he states what stage the river was then at, though I have since come across the statement in Messrs. Denis and White's *Water Powers of Canada*, that the estimate in question was hazarded when the river was high.

In any event, as they well point out, the best judgment of explorers, and even of engineers, as to the heights of falls and the amounts of water discharging over them is frequently very wide of the results disclosed by actual measurements; but, assuming that the above figure for what would be the high-water flow is more or less correct, the mean annual volume would probably be between 30,000 and 40,000 cusecs, thus approximating to that of the Victoria Falls. It is not, then, as great as has popularly been supposed. Indeed, Messrs. Denis and White quote the horse-power of the main fall alone (*estimated for conditions of minimum flow*) at no more than 120,000, and including the rapids both above and below, at 300,000 only.

It is perhaps needless to add that the falls have already been ear-marked for future power development. Mr. J. Russell Smith in his book, *North America*, writes:

"There has already been talk of a great water-plant for the utilisation of the near-by limestone, with electric current and air to manufacture the nitrates that are so important in both chemical manufacture and the production of fertilisers." And again: "The Labradorean waterfall, which now produces only mist, foam and noise, has the prospect of turning wheels and supporting a small town. A few decades hence reindeer slaughter-houses should arise alongside power enterprises on this same coast to which the reindeer should be driven from the ranges of the interior."

Thus yet another of the world's great scenic marvels seems fairly certain to be obliterated in the not distant future.

Before leaving the region of the Grand Falls, we may mention some other notable waterfalls not far away from the latter on a tributary of the Hamilton which enters it some distance below the terminus of the Bowdoin cañon. This river was named by the late Mr. Watkins "the Unknown river." It has since been renamed by the late Mr. Varick Frissell the Grenfell River, but should perhaps more properly be considered as the chief branch of the Attikonak River.

The falls in question consist of two pairs of twin falls some 3 miles apart, each of which is separated into two branches by a high island, the northern branch of the lower falls being again subdivided by a rock in the centre. The upper falls were reckoned to be 90 feet in height, and the lower ones 120. It was not possible to get a view of the southern branch of the lower falls. The photograph here reproduced shows the northern branch which have been named the Yale Falls from their resemblance to the letter Y, the torrents descending on either side of the long, narrow rock in the centre, then converging together and thundering down into the cañon below.

The late Mr. Varick Frissell held that both the Hamilton River, on which are the Grand Falls, and the Grenfell or Attikonak

River, on which are the Upper and Lower Falls just referred to, both issued at different points out of the same lake, namely, as he supposed, Sandgirt Lake. "If so," he writes, "then Sandgirt Lake is a junction where the river may follow either of two channels: the one by Bowdoin cañon and Grand Falls, the other by the Attikonak to Lake Ossokmanuan and thence back to the lower Hamilton via Grenfell River. I mention this because of the possibility that the Attikonak branch may be slowly capturing the waters of the other channel. Upon a plateau of wide shallow lakes where no permanent drainage has become established, many startling changes are likely to occur. Even the Grand Falls may eventually run dry with its burden of waters unloaded upon the Attikonak and Grenfell Rivers."

It would now appear from more recent investigations in the region by the late Mr. H. G. Watkins that it is not the Sandgirt Lake which is the junction, but Lake Ossokmanuan; the waters which feed the Hamilton River flowing thence *into* Sandgirt Lake and thence again, onwards, and not in the contrary direction. This does not, however, affect the interesting possibility which Mr. Frissell put forward.

CHAPTER IX

THE NORTH AMERICAN GIANTS: THE SHOSHONE FALLS ON THE SNAKE RIVER

WITH one or two exceptions, there is a wide gap after Niagara and the Grand Falls of Labrador as regards the cataracts on the North American continent in so far as volume is concerned. Though there are a great number of falls both in Canada and the United States, there is scarcely another besides the two above named which can justly be listed among giant waterfalls. Taking Canada alone, there are, for example, some 417 falls in the Province of Ontario, 234 in that of Quebec and over 640 in British Columbia and Vancouver Island. In the two former provinces taken together, less than fifty exceed 100 feet in height and though in British Columbia the average drop is, as might be expected, greater, the descents are often spread out over a distance of ground, including rapids and a succession of low cascades, and the average discharge is small.

One may note the so-called Dog Falls on the Kaministikwia River, 347 feet in height with a minimum of 14,200 h.p.; those of Shawinigan of much greater volume on the St. Maurice River, which drop 135 feet and develop 130,000 h.p., of which no less than 107,000 have been harnessed; and the Grand Falls on the St. John River in New Brunswick, 120 to 130 feet in height, and with a volume which, in very high flood, may attain to over 95,000 cusecs. But none of these three is of very outstanding interest.

Though, therefore, they are of far less volume than the great falls we have been considering, I propose, on account of their unique setting and the fact that they used often to be called "the Niagara of the West," to include the Shoshone Falls on the Snake River in Southern Idaho as the third of the most notable North American cataracts; though it must be borne in mind that the description here given of them applies to their former and not to their present state, their volume having become so depleted that they have practically ceased to exist to-day.

The main branch of the Snake River has its source in the delectable wonderland of the Yellowstone Park in Wyoming. The Yellowstone River, however, on which the well-known Upper and Lower Falls of the same name occur, has no connection with it, but flows on the opposite side of the Divide, ultimately to join the great Missouri. From its source to its junction with the Columbia, of which it is the main tributary, the Snake drains an area of 13,000 square miles and traverses not far short of 1000 in length. It is in the arid part of its basin, known as the Snake River lava plains, or sometimes, on account of the general absence of water, as the Snake River desert, that the Shoshone Falls occur.

This flat, lava-floored plain extends in the shape of a crescent, its concave side towards the north, for about 350 miles across the southern part of Idaho, and varies in width from 50 to 75. On either side of it rise rugged and serrated mountains, of which the name of the main range, known as the Sawtooth Mountains, is well descriptive. Here and there ancient squat volcanic cones, or "buttes," project themselves above the sagebrush-covered plain, the light, greyish green leaves of this ubiquitous plant rather adding to the monotony of the apparently boundless waste.

At high noontide the whole plain fades away into an indistinct haze, rendering it featureless and indefinite ; but at sunrise and sunset the distant mountains reveal every graven scar of their sculptured slopes and spires, gradually deepening from a pale blue, as the sun mounts higher, to a riot of colour ; sapphire and amethyst and every shade of purple and violet.

In the hot summer afternoons miniature whirlwinds, eddying across the plain, will often give rise to immense columns of dust which sometimes attain to 2000 and even 3000 feet in height. Their hollow centres reveal a spiral motion, from which one would scarcely be surprised to see emerge some such ifrit as appeared to the fisherman out of Solomon's copper jar ; a fancy which is strengthened when, later on, one views the bizarre and titanic architecture of the retreat in which the Snake River has elected to conceal itself.

For at first, as one proceeds across this plain, there is no sign of any river at all, let alone of a great waterfall. But presently far over the olive-coloured desert, which seems as level as a calm sea, a dark line begins to show itself, from one point of which a thin, nebulous mist-cloud may sometimes be seen rising into the air. Then, as one comes up to it, this line suddenly broadens out as if by enchantment, and one finds oneself standing at the brink of a chasm nearly half a mile in width and over 800 feet in depth. And there, far below, between mighty black walls of lava and basalt, terraced and columned, and buttressed by many a fantastic spire and pinnacle, the Snake River, here close on 1000 feet in breadth, first plunges down in foaming cascades some

30 feet among a dozen or more rocky islets and then takes a sheer leap of 190 into a deep beryl-green pool below. A dull roar rises up from the depths, accompanied by clouds of spray which will sometimes rise up, for 1000 feet, topping the edge of the cañon's lip, and at others, as the wind or the volume varies, will scarcely reach as high as the brink of the fall.

The barren savagery of the scene, unrelieved by vegetation, except for a few stunted fir trees standing like sentinels on the edges of the lower cliffs, is what immediately arrests and impresses the eye as one gazes downwards. Yet the jetty blackness of the rocky walls, contrasted with the deep green of the river, the white foaming masses of the plunging fall and the delicate blue of the sky overhead, provide a combination of colour that almost makes one forget the suggestion of an inferno that is at first connoted.

The descent to the falls is by a narrow path which winds among the lava ledges. One can go right to the foot of them ; for while on the opposite side the wall of the cañon descends sheerly into the green basin, here there is left a shingly beach from which one can look upwards at the descending flood. The whole cañon is filled with the echoing uproar as the waters fall in thunder into the deep unbroken pool, which is devoid of rocks, and from its smitten surface volumes of white foam go surging upwards in rolling clouds to the heights above.

The shape of the falls is that of an indented crescent, reminiscent on a smaller scale of the Horseshoe at Niagara, though here the leap is higher. The face of the fall, " a cataract of snow with an avalanche of jewels," as one writer has described it, is broken by many a concealed shelf and ledge whose presence is betrayed only by the glancing outwards of huge rockets of spray, for here, as in the case of the great San Martin Fall of the Iguazu, the volume is generally sufficiently great to conceal these projections.

Indeed, the formation of the cataract is such that, though of very much less volume than its eastern rival, the epithet which has so often been given to it of " the Niagara of the West " is by no means undeserved ; while the titanic grandeur of its setting, unique among all great falls, is of course incomparably superior.

According to measurements of volume taken in 1897, before any of the river's flow had been diverted, by the hydrographical division of the United States Geological Survey, the mean discharge at Montgomery Ferry about 50 miles above the falls was

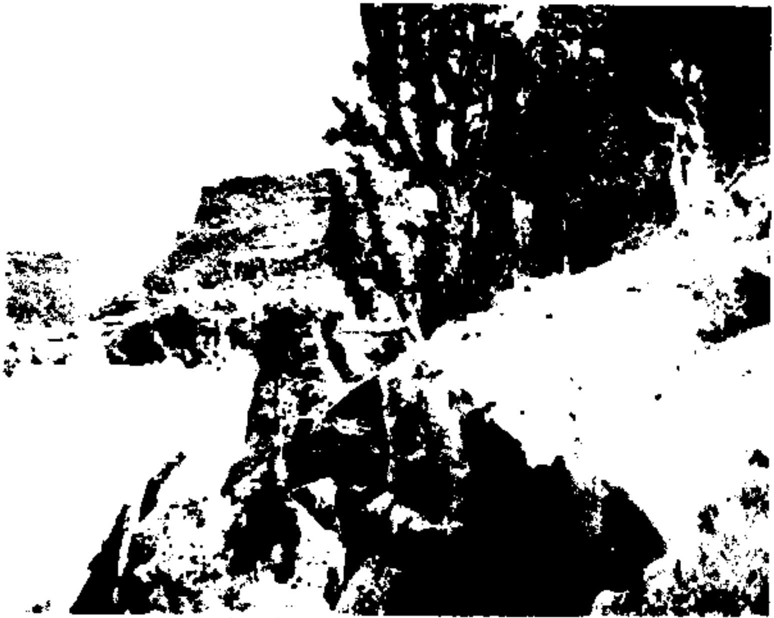
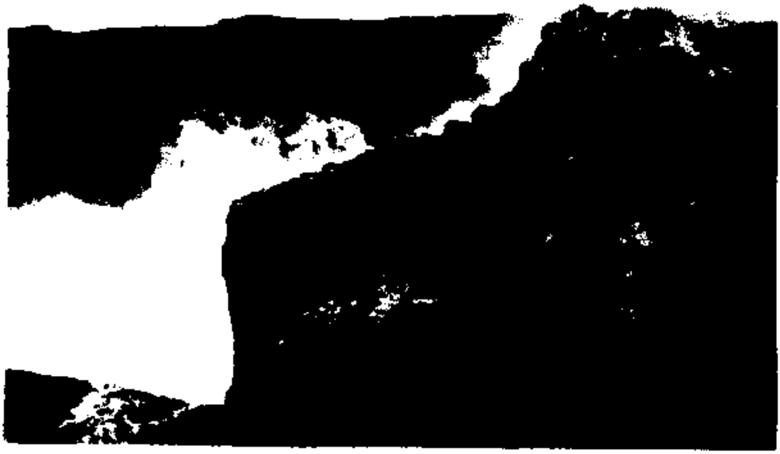


Photo by courtesy of the United States Geological Survey, Washington, D.C.

WATER FOR IRRIGATION AND POWER



10,064 cusecs, which from August to October, when the river is low, may sink to 4400. The usual flood volume, which is reached in May and June will attain to the respectable figure of 26,000. It may on occasions, however, greatly exceed the latter amount.

Mr. Julian D. Sears, the Acting Director of the Geological Survey, U.S. Department of the Interior, Washington, D.C., who has kindly given me a good deal of data regarding the Shoshone Falls, tells me that the highest volume on record occurred on June 23rd, 1896, when the flow at Montgomery Ferry reached 53,100 cusecs. "This figure," he adds, "represents, probably within 10 per cent, the maximum flood at Shoshone Falls during the period covered by records."

The falls' dimensions compare fairly closely with those of the American fall at Niagara, the mean volume and width being but little less than that of the latter in its former undepleted state, but the height being greater ; a fact which, added to the absence of talus at their base and their far more broken face and Plutonian surroundings, gives to the Shoshone Falls a far less tame aspect than the other. The 30-foot drop among the rocky islets which precedes the main leap further enhances their superior diversity. The fantastic forms of these boulders, among and over which the torrent surges in deep emerald and creamy lace, take many shapes. There are rounded domes, columnar pillars, cavernous hollows ; while on either side black portals of lava, towering 700 to 800 feet above the stream, seem to provide a gateway such as William Beckford might have envisioned to the enchanted kingdom of Eblis.

In an account of the falls written many years ago, Mr. Clifton Johnson relates the story of an Indian half-breed who, on being challenged by a friend to so do, actually leapt from their brink into the deep pool below and, escaping with only a few bruises, at once became famous. Subsequently, an enterprising showman arranged with the man to repeat the performance, but the second attempt never came off as the half-breed, having in the meantime decamped with funds belonging to his would-be employer, was lodged in the safer retreat of the local gaol !

The whole cañon through which for many a mile the Snake has carved its way, is a succession of weird Dantean surprises. The Shoshone Falls, or "Pahchulaka," to give them their Indian name, are but the greatest of a series of falls. The first are the Idaho Falls where the river takes a sudden plunge of 30 feet over a great ridge of basalt into a narrow chasm below.

Next in order going downstream come the American Falls where the cañon really begins and whence it extends to the Idaho-Oregon boundary. These, which are of greater volume than the Idaho, have a drop of 50 feet. They are succeeded by the beautiful Twin Falls, no more than from 3 to 4 miles above those of Shoshone, and surpassed only by them in magnitude. They are, or rather were, well worth a separate visit, being 187 feet in height. Here, as at Shoshone, the cañon widens out into a broad, circular expanse, packed with great slabs and ridges of lava and bounded by the usual towering black walls. A rocky island divides the stream into two almost equal branches. The one to the left, facing downstream, plunges down almost perpendicularly into the emerald basin below. The right-hand branch is more sloping, the crest of the fall being greatly worn, and rushes down in a steep cascade. The view of them here given, which was taken at high water, shows an additional third fall on the right. Below the Shoshone, again, come the Auger Falls, and after them the Salmon Falls which drop 25 feet.

Grim as the cañon is, it is not by any means entirely barren rock. In some of the side ravines are to be found an abundance of beautiful ferns and mosses; while in the neighbourhood of "The Thousand Springs" the precipices are covered with verdure. Indeed, in many places even the rough talus slopes in the cañon have now been planted with trees and vines among the fallen blocks of rock, and from Shoshone Falls westwards groups of ranches have sprung up, mostly on the northern bank of the river, which are irrigated to the extent of many thousands of acres by water from the springs above mentioned, as well as extensive areas in places where the cañon has opened out, and where shelter is afforded by its protecting walls.

These springs form one of the most interesting and curious features that the cañon of the Snake River has to show and are deserving of special mention. Though in south-east Idaho the Snake River receives many tributaries from the east, such as the South Fork and the Blackfoot Rivers, and a few small streams, such as the Salmon and the Bruneau, from the south, on its northern side for a distance of about 350 miles not a single perennial stream joins it, except only the Malade River, and that but intermittently and when not wholly used up for irrigation. And this in spite of the fact that in the northern part of its basin the rainfall on the mountain ranges is probably greater than that to the south.

Photo by courtesy of the United States Geological Survey, Washington, D.C.

OF WATER FOR IRRIGATION
all on the right.

The cause of this is the extensive lava plain on which all the water either evaporates, or sinks and disappears in the countless fissures with which it is seamed. But though the water fails to reach the Snake River in the form of surface streams, it does so in the shape of extensive and voluminous springs. These literally pour out of the upper sides of the cañon wall from heights of 185 feet and over, forming numbers of beautiful and separate cascades whose aggregate volume has been reckoned to be greater than that of the Snake River itself, no less indeed, according to one estimate, than 20,000 cusecs.

It is along a section of the river below Shoshone Falls, extending for some 18 miles, from a point above where the Salmon River comes into it down to Bliss, that they are particularly numerous and have come to be called "The Thousand Springs." The water is often of a bluish tint, due to fine particles held in suspension, and several of the streams are, oddly enough, inhabited by trout, which one would scarcely expect to find in the central part of so arid a plain.

That the Shoshone Falls have now practically ceased to exist was perhaps inevitable in view of the importance, and indeed necessity, of irrigation for all the surrounding region. Of Idaho's total area of 84,000 square miles, no less than 65 per cent, or 35,000,000 acres, was formerly arid, and almost the whole of this is within the drainage basin of the Snake River. Consequently it is on irrigation derived from the latter that the agricultural development of so great a part of the State depends. It has now been practised since the early nineties.

Where all was formerly desert there are now tens of thousands of acres under cultivation, including orchards, vineyards, alfalfa and, to some extent, cereals, principally maize, etc. This has been brought about by the construction of enormous dams, reservoirs and canals. Even before 1906 one of the largest of the former in the United States, and indeed in the world, had been made at Milner, 23 miles above the Twin Falls. One of the two canals which issue from it is 69 miles long, 80 feet wide at the bottom and 120 at the top. Of reservoirs that of the American falls, constructed in 1926, has a capacity of 1,700,000 acre-feet.

There are, besides, other developments such as that of the Idaho Power Company which has harnessed Shoshone Falls by means of a series of low concrete dams across the head of them, diverting the flow into tunnels and penstocks on the north side of the river. In fact, to quote from a letter which I received from

Mr. Sears: "At the present time the Shoshone Falls is dry for the greater part of the year, all of the water being diverted through the power-house, and with increasing use of water for irrigation little, if any, water will flow over the falls unused."

Thus is the glory of "Pahchulaka" departed; the "Niagara of the West" exists no longer.

CHAPTER X

SOME FURTHER NOTABLE FALLS OF NORTH AMERICA

I HAVE already mentioned at the commencement of the last chapter a few other waterfalls in North America, such as the Dog Falls, the Shawinigan Falls and the Grand Falls on the St. John River, New Brunswick, which, though sufficiently imposing, are scarcely of a magnitude great enough to be included among the giants. Many of the most famous falls on the continent are indeed to be found in the various National Parks; but before discussing them, there are a few others worthy of notice, and indeed of formidable pretensions, though they are still very little known and full details about them are difficult to obtain.

One of these is the Nastapoka Fall which occurs on the river of that name where it falls into the Nastapoka Sound about half-way down the eastern coast of Hudson's Bay. Mr. George Binney, who devoted a few lines to it in a paper on Hudson's Bay which appeared in the *Geographical Journal* for July, 1929, states that the region has been visited by very few white men other than fur traders. He describes the falls as being 160 feet in height and 60 feet wide at the crest, and to judge from the photograph accompanying his article the volume appears to be very considerable. On a calm day, he tells us, the spray will rise to twice the height of the falls. The river descends over the cliff into a narrow gorge which has great depth and extends about a quarter of a mile to the sea. As he further states, all the rivers flowing into the Nastapoka Sound have falls on them, but they mostly descend over a series of steps rather than boast any great leaps.

In passing, one may also mention on the James Bay slope the Conjuror Chute and Hell Gate on the Missinabi River, height 250 feet with a minimum flow of 2600 cusecs; the Breakneck Fall and Rapid on the Opazatika River, with 150 feet drop and a minimum volume of 1000 cusecs; the Long Rapid Fall on the Mattagami River, of a like height but with a 5000 cusecs low water flow; and the Rabital Cascades on the Bonnechère River which descends, in all, 405 feet.

As little known as the Nastapoka Falls are those of Kinuseo on the Murray River in the Canadian Rockies, which were first located as recently as 1914 by Mr. S. Prescott Fay. The only account I have seen of them is one by Mr. Prentiss N. Gray in Volume LXXX of the *Geographical Journal*. "The great river," he writes, "now swollen by three tributaries from the west, poured over a series of shale ledges which extended across its bed, then made a sudden drop of 235 feet to a deep pool, on both sides of which rose bleak cliffs seeming to frown on the river for having escaped their grasp. From the pool the river took up its peaceful way around a timber-covered island lying directly in front of the fall."

But more interesting than either the Nastapoka or Kinuseo Falls are the Red River, or Grand Falls, on the Little Colorado River, near Flagstaff, Arizona, to which my attention was first directed by Miss M. S. Johnston, F.R.G.S., who not long ago paid them a visit and has been good enough to furnish me with some particulars.

Messrs. Harold S. Colton and Frank C. Baxter in their booklet, *Days in the Painted Desert and the San Francisco Mountains*, describe these falls as "A chocolate Niagara, not so wide across but a little higher than its prototype—such are the Grand Falls when the Little Colorado River comes down in flood. A yellow mist fills the gorge, drying as it strikes the face, forming a coat of dust, hard to remove. The falls, 185 feet high, are worth a visit, not only as a novel experience, not only for the gorgeous setting, but also for the geological story that they tell . . ." And they go on to describe how in years gone by the Merriam Crater, a volcanic cone lying between the San Francisco mountains and the river, emitted a great stream of molten basalt which plunged into the Little Colorado over the edge of the cañon wall, blocking the course of the river and flowing down its bed for a distance of 20 miles. One is reminded of the following lines by a poet whose name at the moment I am unable to recall :

> "There the red Hell river bellows and hisses
> Plunging in flame to the shrieking abysses."

It is by gradually cutting a new channel in the relatively soft shales to the east of this lava tongue, and then plunging back again over the wall of the old cañon, that the river has formed the present falls and has re-excavated much of its former bed.

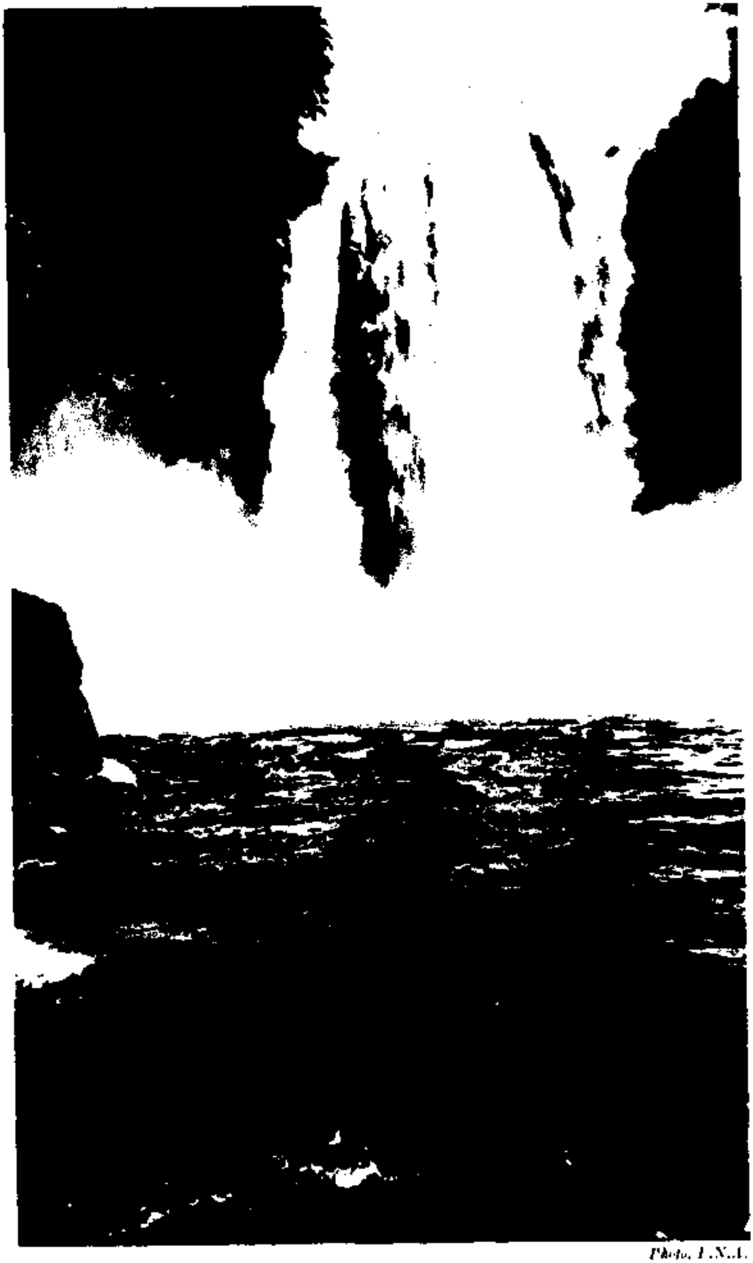
As will be seen from the two views here reproduced, the falls descend over gigantic steps, and Miss Johnston tells me that the effect of the red-coloured water pouring over these is extremely curious. Both the front view by Miss Johnston and the side view by Mr. Mendenhall, Director of the U.S. Geological Survey, were taken at comparatively low water. As a matter of fact the

Photo. Courtesy of Mrs. M. S. Johnston

THE GRAND FALLS ON THE LITTLE COLORADO RIVER

Above, Front View *Below*, Side View

Photo. Courtesy of Mr. [illegible], [illegible]



Photo, I.N.A.

THE SNOQUALMIE FALLS
Height, 268 feet.

falls are not perennial, and become practically dry during May, June and part of July, when the Navajo Indians, so Messrs. Colton and Baxter relate, water their sheep in the deep pool below the cliff. After the summer rains, however, the volume may be very considerable. A Captain Sitgreaves, who was commissioned by the U.S. War Department in 1851 to see if the Little Colorado River was navigable to the sea, was the first white man to describe these falls. The early Spanish explorers evidently failed to come across them.

While on the western side of the continent, reference may be made to the very numerous falls in the Cascade Mountains, of which two may be singled out as especially worthy of mention, namely, those of Snoqualmie, and the Multnomah Falls on a creek which runs into the great Columbia River.

The former, which have a minimum flow of about 1000 cusecs, are reckoned to be able to develop 100,000 h.p., and have already been harnessed to a considerable extent, power being transmitted from them to Seattle, Tacoma and Everett. They fall in a sheer plunge of some 268 feet, and their swirling foam and mist set against a mountain background, and surrounded by woodlands of vivid green, has made them rightly famous as one of the chief attractions of this region. Below the falls the Snoqualmie River unites with the Skywamish to form the Snohomish River, which flows into Puget Sound about 18 miles below the junction of the two branches.

Far higher, though of more slender volume, are the Multnomah Falls, which descend over a deep recess cut into a perpendicular wall that almost overhangs, causing the torrent to leap out sheer through the air for its entire drop of 840 feet. By the time the water reaches the deep pool below, so overshadowed that it is almost black in hue, it is largely dispersed into fine spray, at least, in the dry season; for after the melting of the snows in the circling mountains above, the stream takes on the dimensions of a good-sized river and then comes hurtling down in what has been described as "appalling sublimity." On the farther side of the pool the stream descends through a gorge which is spanned by a rustic bridge, and a little further down it forms a second fall of 75 feet. Thus the total descent of the Multnomah Falls is 915 feet.

Turning again to the eastern side of the United States before discussing the more noted falls in the National Parks, we cannot, of course, leave out the famous Montmorency Falls close to

Quebec, though they are now shorn sadly of their former magnificence. The power obtained from them is used for the tramway system in Quebec City and the suburban service to St. Anne de Beaupré, and operates as well large cotton mills at the foot of the falls. Their height, nearly 270 feet, is approximately the same as that of the Snoqualmie Falls. One of their greatest and most abidingly restful charms is the long narrow gorge above them which consists of rocky walls cut into the form of steps, through which the river boils in an uninterrupted succession of rapids before it takes its leap over the precipice to join the great St. Lawrence. The numerous and unexpected twists and turns of this ravine and the dense growth of fir trees which in places almost overhang it render it peculiarly attractive.

Then, again, close to Washington, D.C., the foaming cascades on the Potomac are decidedly impressive. But, truth to say, so many of the minor waterfalls in the eastern states have now been practically destroyed for power purposes that it is scarcely worth while to-day to draw the reader's attention to them, though in former days many might have been singled out for admiration.

Happily the waterfalls in the various National Parks will, as far as one can at present foresee, always remain exempt from spoliation. The most famous of these parks, and the ones which also boast the finest falls, are the Yosemite and the Yellowstone. Their wonders have, of course, so often been described by scores of well-known writers that one is almost tempted to apologise for dwelling on them further, were it not that one is bound to include their aqueous leaps in any book which deals with notable waterfalls.

The Yosemite Valley, which lies near the crest of the Sierra Nevada, the great alpine range of California, was first discovered in 1851 when some mounted Volunteers under the command of Captain John Boling pursued to their mountain fastnesses the Indians that infested the region in an attempt to put a stop to the latter's depredations. It was made into a national park in 1890, but tourist traffic to it began as early as 1856, after a trail had been opened by J. M. Hutchings in the previous year. The total area of the park is some 1125 square miles, of which the Yosemite Valley, about 7 miles in length, is but a small part, the Hetch Hetchy Valley and the Tuolumne Cañon being also included in it.

The following list of the chief falls with their correct heights is taken from a *Report of the U.S. Geological Survey*, by F. E. Mathes (1920):

Fall.	*Height in feet.*
The Upper Yosemite	1430
The Lower Yosemite	320
The Ribbon	1612
The Virgin's Tears	1170
The Bridal Veil	620
The Sentinel	619
The Illilouette	370
The Vernal	317
The Nevada	594

Of the above the most celebrated are the Yosemite, or, as they are usually called, the Great Yosemite Falls, on account of their unusual height, to which I have already referred when discussing the high falls on Roraima. The head of these falls is stated by Mr. Mathes to be 2565 feet above the floor of the valley. The total drop of the actual falls is 2425 feet, made up of a sheer upper leap of 1430 feet, a lower fall of 320 feet, and a succession of intervening cascades between these two, extending from a quarter to half a mile, which have an aggregate drop of 675 feet. But viewed from a distance the whole drop has the appearance of a single fall. About 2 miles above the falls' crest the stream is 40 feet wide, with a depth at the time of the melting of the snows of about 4 feet. The width at the crest is 35 feet, but the descending column when swayed about by the wind will expand to as much as 300 feet in breadth and more in its lower portion.

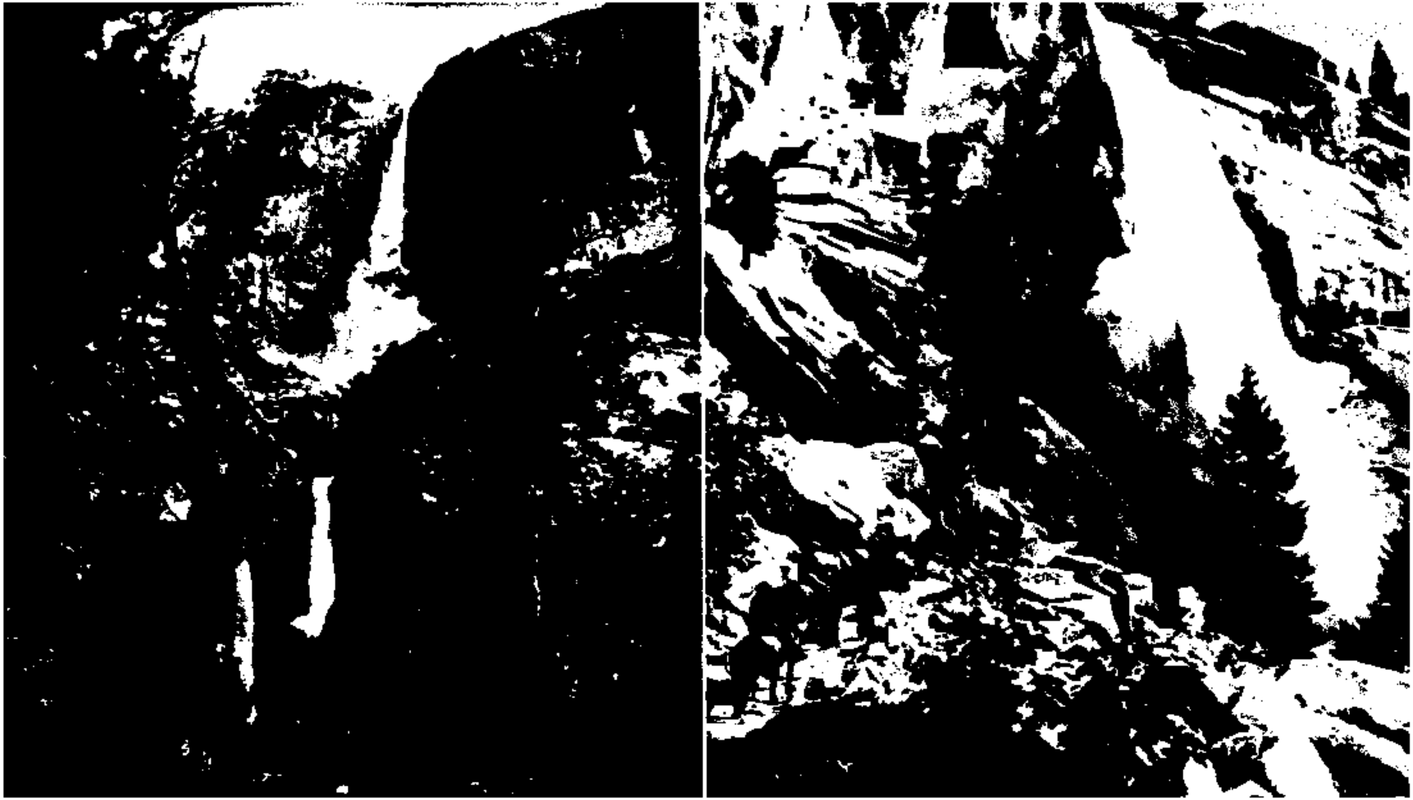
Mr. John Muir, the well-known authority on the Yosemite Valley, has described how on one occasion he got on to a ledge extending back of the fall to look at the effect of the moon shining through its edge, and how the fringe of the plunging torrent, pressed by the wind back against the cliff wall, came down upon him with tremendous force, some of the heavier masses of water striking him like cobblestones. Luckily for him the great column did not come nearer the cliff, and after lying huddled up on the ledge he was able to escape as it was wafted outwards again.

In the gorge that lies between the Upper and Lower Yosemite Falls there are as many as six intermediate falls which Mr. Muir describes as forming a series " more strikingly varied and combined than any others in the valley " ; yet, as he further says, very few of the visitors there ever see them or even hear of them.

The noise of the great fall at ordinary times has been compared to the crackling of hailstones on the roofs, but when swollen by rain or the melting snows up on the Sierra, its loud thunder fills the whole valley with its echoes. Its swaying and sparkling mass admirably relieves the harsh and arid background of the tremendous granite precipices over which it plunges. The drop of the Ribbon Falls is even greater than the upper leap of the Yosemite, but the volume is but slight, giving an appearance of threads of silver which seem to glide rather than fall down the cliff face. Its crest is 3048 feet above the valley's floor.

More lovely than either is the fall of the Bridal Veil, so called because its darting jets of water, torn by the wind and shooting out like dazzling rockets, look from a distance like an immense silver webb floating across the air. When shot through in the sunny afternoons by the prismatic colours of the rainbow, it assumes an almost unearthly beauty. The Indians named it "Posono," or "The Spirit of Evil Winds," and nothing would induce them to go near it or to spend a night in its vicinity. Mr. Mathes' figure of 620 feet for its height must, I think, refer only to its principal leap, as other accounts make it approximately 900 feet ; first a sheer fall of 600 feet, then a slanting rush over a sloping pile of débris, and next a further drop of 300 feet ; but at a distance the whole descent gives one the idea of a single fall. It has sometimes been compared to a larger edition of the famous Staubbach Fall in the Lauterbrunnen Valley in Switzerland, but its superior volume makes its Swiss rival seem a very small affair in contrast. The width at the crest is variously given as being from 30 to 70 feet. It is the incessant agitation of the air, due to the downward rush of the torrent, that the Indians imagined to be caused by some evil spirit which haunted the spot.

All the above-named falls are on tributaries of the Merced River which flows through the valley and on which the most voluminous cataracts occur, namely, the Nevada and the Vernal Falls. The former is about half a mile above the latter and is not far short of double its height. Its setting is far the more savage and bare, and rushing out, as it does, from a twisted and rocky channel to the edge of the precipice, it plunges down with a more boisterous display of foam and fury than its neighbour. Below the fall the river rushes on with great velocity through a gorge walled with immense slabs of granite and in a channel of about 40 yards in width, as if it was in a great hurry to take its further



leap at the Vernal Falls. The latter, named by the Indians "Pivaak," or "The Cascade of Sparkling Crystal," is 80 feet in width. The river falls with a noise like thunder over a vertical rocky wall which cuts diagonally across the ravine of the valley, and then loses itself in a splendidly wooded crevasse.

We may note also the Wapama Falls in the Hetch Hetchy Valley, and the so-called "Cart Wheels" on the Tuolumne River. John Muir describes the latter as: "One wild, exulting, onrushing mass of snowy purple bloom spreading over glacial waves of granite without any definite channel, gliding in magnificent silver plumes, dashing and foaming through huge boulder dams, leaping high into the air in wheel-like whirls, displaying glorious enthusiasm, tossing from side to side, doubling, glinting, singing in exuberance of mountain energy." The sloping torrent as it strikes projecting rocks rises 50 feet or more in the air, thus forming the water-wheels.

A curious legend, purporting to account for the manner in which the torrents of water came to pour into the Yosemite Valley, has sometimes been related which recalls in a slight degree the mythical origin of Tequendama to which I have already referred. On the vast face of the rocky rampart of El Capitan there can be seen engraved the lineaments of a giant's head with long floating black hair, the eyes of which appear to be ever regarding the valley intently.

This personage, according to the Indians who formerly inhabited the spot, was Tutokanula, the ancient king of the region long years before the "Pale Faces" invaded it. Under his benign rule, the Redskins, his subjects, long dwelt in peace and happiness, till one day a goddess, the charming Tissaak, appeared to Totokanula on the crest of the Southern Dome, which at that time was not yet split into two parts. From that moment, the King was so bewitched by Tissaak's loveliness that he thought no more of mankind. The harvest seemed doomed to perish for lack of rain, and famine became inevitable.

The Indians supplicated Tissaak to save them, whereupon she prayed to the Great Spirit to aid them. Her prayer was heard, and the latter split in two the Southern Dome, thus letting the waters flow down into the valley from the slopes of the upper mountains. Rain, also, fell abundantly and the harvests were saved. But Tissaak, in return for this favour, had to be sacrificed to the Great Spirit, and never more was seen thereafter. Unable to remain without his beloved, Totokanula then left the valley for ever, but not before he had carved on the cliffs of the Southern Dome the features of Tissaak, and upon the face of El Capitan his own image. Thus their effigies contemplate one another eternally and also the valley where they had lived and loved so long.

The Yellowstone Park in north-west Wyoming has nearly three times the area of the Yosemite, being 3348 square miles in extent. It was first discovered by a certain John Colter in 1810, who took refuge there from hostile Indians as he was returning home from the Lewis and Clark expedition. The two chief falls, namely, the upper and lower Yellowstone Falls on the river of the same name, though not as high as those on the Merced in the Yosemite Valley, probably exceed them considerably in volume. The Yellowstone River issues from the Yellowstone Lake, which is situated at an elevation of 7740 feet above sea-level and has an area of 139 square miles. The discharge of the river where it leaves the lake, taken in September, the driest month of the year, is 1525 cusecs, which of course is greatly increased at the high-water period. The upper fall, though its height is no more than 109 feet as compared with the 308 feet of the lower one, is considered by many to be the most picturesque and remarkable of the two, both owing to its formation and to the wonderful velocity of the river above it.

For upwards of half a mile before reaching the brink of the fall, the Yellowstone rushes down over a succession of rocks of lava, and by the time it takes its leap the speed of the torrent is so great that almost all the spray which covers the water is projected in advance. At the crest it has a depth of 4 feet and a width of 80 feet. As it shoots out, it encounters an angle of rock which causes it to rebound to a distance of 60 feet, and to form an immense fan which dissolves in clouds of spray.

As in the case of the Nevada and Vernal Falls in the Yosemite Valley, so here about half a mile separates the lower fall from the upper. The latter has a width of about 90 feet, but though the current is violent it is not preceded by any such rapids as is the upper fall. The great mass of water plunges sheer with what has been described as " a dull humming sound " into a huge circular basin overlooked by tremendous ramparts of rock, melting as it does so into sheets of foam.

But it is the vast cañon in which the falls are set which presents the crowning wonder and glory of the scene, and which, though not so wide nor deep as the famous Grand Cañon of the Colorado,

yields no whit to it in splendour of colour or in the wondrous spires and pinnacles into which its enormous cliffs are carved, the work of the frosts and erosion of untold ages. To attempt to describe it would be a task which the most gifted writer might well despair of achieving. The following passage from Mr. Rudyard Kipling's *American Notes* will give as adequate an idea of it as can perhaps be hoped for :

"One wild welter of colour—crimson, emerald, cobalt, ochre, amber, honey plashed with port wine, snow-white, vermilion, lemon and silver-grey in wide washes. The sides do not fall sheer, but were graven by time and water and air into monstrous heads of kings, dead chiefs, men and women of old time. So far below that no sound of its strife could reach us, the Yellowstone River ran—a finger-wide strip of green jade. . . . The canyon was burning like Troy town, but it would burn forever, and thank goodness, neither pen nor brush could ever portray its splendours adequately."

Three miles below the lower fall the cañon attains a depth of 1050 feet, which increases to over 2500 still further down. Tucked away in a side ravine and so concealed that the visitor might easily overlook them altogether, are the more slender Tower Falls for the accompanying view of which I am indebted to Miss M. S. Johnston. They drop in a single leap of 132 feet, and then the stream rushes down a narrow cañon, foaming over broken rocks to join the Yellowstone River. The sides of the deep ravine are hollowed with caves and clothed with vari-coloured mosses constantly bedewed with the clouds of spray wafted by the cataract. As the reader will note from the photograph, a remarkable feature of these falls is the curious cluster of spires and pinnacles which soar above them, all eroded by the action of the water, one of which towers up to a height of over 400 feet. Some stand like sentinels near the very edge of the fall, whence its name of the Tower Falls.

The Glacier National Park with an area of 1534 square miles is situated in north-west Montana and was created in 1910. It boasts several waterfalls of great beauty but mostly of rather slender volume. One of the most notable is the Morning Eagle Fall which comes down from a now shrinking glacier with a tremendous roar, plunging from ledge to ledge over a series of gigantic steps. It used to be a great rendezvous of the Blackfoot Indians from whom the park property was bought. There are also the Golden Stair Falls which, as their name implies, have a like formation; and from the snow-fields on the face of Gunsight Mountain some fifteen or twenty further cascades can be seen tumbling and streaming down to the floor of the valley.

The Trick Falls provide a curiosity here. At low water the torrent emerges from a cleft not far up from the base of the precipice; but when the river is high the water pours as well in considerable volume over its brink; the lower fall, which is fed by some subterranean channel, being then hidden by the upper. A similar instance on a smaller scale, as far, of course, as the volume of the stream is concerned, occurs at Malham Cove near Settle, in Yorkshire. Here at ordinary times the water emerges from an underground passage at the base of the cliff which is 286 feet in height, but when swollen by rain the stream will also pour over the top. I remember it was once suggested to block up the subterranean channel from above so that all the water might form a perennial fall over the full height of the precipice, but for some reason or other, the force of which is not easy to understand, the idea was strenuously objected to. Had it been carried out, we should have had at Malham Cove one of the finest falls in England, as far as height is concerned.

Of the various cascades in the Canadian National Parks, such as the Kootenay, the Banff, the Mount Revelstoke and the Yoho Parks, the finest falls are in or near the latter, namely, the Takakkaw Falls and the Yoho Twin Falls. The former which plunge out of the Daly glacier have a considerable volume and a sheer leap of some 1200 feet; while not far to the north-west of them are the Yoho Falls, two twin cataracts dropping side by side to a depth of some 900 feet. One may also mention the fine Bow Falls, near Banff, though the latter are not more than about 50 feet in height.

On the milk-green Illecillewaet River, too, which drops 2000 feet from its glacier source to join the great Columbia, there are some imposing, though low, cascades; nor must one forget, while speaking of the Columbia, to note the falls on another of its tributaries, the Willamette, in Oregon, though the latter have now been long harnessed to supply power to paper and woollen mills in Oregon city.

On the Columbia River, by the way, at a spot in the State of Washington known as Dry Falls, one of the mightiest cataracts in the world must have existed in the dim prehistoric ages. Here over a wall 400 feet high and about 3 miles wide, the immense stream of the Columbia once thundered down. These Dry Falls form the southern extremity of the Grand Coulee, on the walls of which seven distinct lava flows can be traced through which the stream bed was cut.

Below Dry Falls a chain of lakes still remains as vestiges of the former flood, the river having cut for itself another channel. So, too, on the mighty Mississippi at Minneapolis, the now low St. Anthony's Falls are a remnant of what John Arnold Keyes calls "the most stupendous cataract the world ever saw, having a perpendicular descent of 600 feet." An instance of one of these "dead" falls also occurs in Europe where the Indal River in Sweden, by changing its course near Bispgarden, in 1796, has left dry the bed of a former considerable fall, now called Doda, i.e. "dead" fall.

Before leaving the New World, there are two waterfalls in Mexico and a few cascades in the West Indies which are worthy of notice. The first of these, known as the Juanacatlan Falls and sometimes, also, as the Mexican Niagara, occurs on the Santiago River, also called locally the Rio Grande, in the State of Jalisco. The falls are from 4 to 5 miles from El Castillo, whence there is a tram-line to them, and about 16 miles from the city of Gualdalajara. In its upper course before entering Lake Chapala, the river, which is one of the most considerable in Mexico, is known as the Lerma, and up to the point where it debouches into the lake it has traversed over 280 miles. Lake Chapala, or El Mar Chapálico, is the largest of the Mexican lakes, being about 70 miles in length by 20 in width and 5159 feet above sea-level. It is celebrated for the extraordinary variety of bird life in its vicinity on account of the mildness of the climate which has sometimes been compared to a perpetual Indian summer.

Though no more than some 66 feet in height, the falls, which make their leap shortly after the river exits from the lake, have a width of 525 feet and afford an imposing spectacle after the rains, when a tremendous volume of dark brown water crashes with a dull roar into the pool below. In the dry season, however, which is usually from September to June, the cataract consists of thirty or more small separate falls and the greater part of the precipice is bare rock. Clouds of silver mist, shot through with innumerable rainbows, crown the crest of the falls. During the flood season masses of blue lilies, which have become uprooted, pass over the cataract and again find a footing and grow vigorously in the river below. The falls have been harnessed for some time past to supply electric light and power to Guadalajara. Some 5 miles to the south-west of the latter, the Santiago River plunges with an awe-inspiring roar through the well-known Barranca de Oblatos, which has a depth of 2000 feet. It finally flows into the Pacific a little north of San Blas after a total course of nearly 470 miles.

The falls on the Necaxa River, which occur in a barranca in the district of Huachinango, in the State of Puebla, are also known as the Tecalutla Falls. Their total height formerly aggregated about 1600 feet, of which the principal leap was 540. I use the past tense as they are now practically destroyed, having been harnessed by American Concessionaires who have spent something like 50,000,000 dollars in creating a series of immense reservoirs covering more than 6000 acres in order to preserve the entire rainfall above the falls, which is here about 135 inches annually. More than 150 separate streams were diverted into these reservoirs in order to store up the water during the rainy season and to have it available when the nine months drought set in. Power is supplied over a system of aerial wires supported by thousands of steel towers to Mexico City nearly 100 miles away and, as well, to the mines of El Oro.

Other Mexican falls, which I can merely mention here, are the Cascada de Basacáchic, in the Sierra de Tarahumare, in the State of Chihuahua, one of the most notable in Mexico, though dropping no more than 93 feet; and the Salto de Chimal and the Tecalco Waterfall, both situated near Amecameca, not far from the bases of the famous mountains of Popocatepetl and Iztaccihuatl. The former of these is said to be very fine.

As regards the West Indies, one of the finest waterfalls is situated in Jamaica, near the Bay of Waterfalls, or Ocho Rios, where as many as eight rivers pour into the sea. They are called the Roaring River Falls and drop 150 feet on a width of from 175 to 200. They are interesting in that the river, which is usually copious, emerges from a subterranean passage in the limestone 2 miles inland, and the falls are remarkable for the deafening roar they emit as they plunge down in innumerable jets and spurts of spray. A writer has described them as "feathery and brilliant, massed together, clustered, glancing at a hundred different angles, breaking into a thousand foam-jets, each curtained with an iridescent veil of falling water, which seems to drip from the branches of the trees that form the foreground, growing as they are in mid-stream." Not far away, but less fine, are the White River Falls.

Extremely lovely is the Blue Basin Cascade in the valley of Diego Martin in Trinidad, where a number of small streams unite to pour over a cliff into a pool of the most vivid cerulean tint, whence the name of the falls. The beautiful tropical vegetation in which the falls are set, and the myriads of radiant humming-birds which flit like jewels in and out of the spray, render them more than ordinarily attractive. On the same island, and with a plunge of 340 feet between half-enclosing walls bedecked with floral finery no less lovely than that which engirdles the Blue Basin Falls, are those of Maraccas. Charles Kingsley wrote of them :

"Here it is, opposite, a grand spectacle indeed. From a perpendicular wall of rock, more than 300 feet in height, down rushes a stream of water, splitting the air and producing a constant shower, which renders this lovely spot singularly cool. Nearly the whole extent of this natural wall is covered with plants, among which you can easily discern numbers of flowers and mosses. . . . The water here is absolutely colourless—pure, limpid and unstained which splashes merrily at your feet, and flies daintily, all refined into spray, into your face, as you scramble up the wet rocks and front the whispering Naiad shrouded behind her long white veil."

Another noted Trinidad fall occurs in the Caura Valley, which is also over 300 feet and of greater volume.

Passing over the Salto de la Toma, the Salto de los Cocos, the Saltos del Violon and de los Mameyes, all in Haiti, and the well-known falls of Orosi in Costa Rica, we may mention in conclusion a fall of which I have been unable to discover the name in the Island of Guadaloupe, and which can be seen from the Bay Sainte Marie in the mountains back of the coast. This fall is interesting as it may possibly have been the very first waterfall to be seen by Europeans in the New World. Columbus himself mentions it when he discovered Guadaloupe, formerly known to the Indians as Turuqueira, on his second voyage. It was in Guadaloupe that he awaited the return of some of his men who had wandered off and had been lost in the forest. Washington Irving writes of this fall :

"As they approached within three leagues, they beheld a cataract of such height that, to use the words of the narrator" (i.e. Columbus himself), "it seemed to be falling from the sky.

As it broke into foam in its descent, many at first believed it to be a stratum of white rock."

We will now take our leave of South and North America to visit the giant and lesser notable waterfalls of the great African continent.

CHAPTER XI

THE AFRICAN GIANTS: THE AUGHRABIES FALLS ON THE ORANGE RIVER

IT is a widespread error that the first European to see and describe the Aughrabies Falls was the missionary, George Thompson, who visited them on August 15th, 1824, and re-christened them "King George's Cataract." In some quarters, indeed, such as the last edition of the *Encyclopædia Britannica*, their discovery, again quite wrongly, is attributed to John Campbell, also a missionary, who visited the district in September, 1813, but who came away without seeing the falls at all, though he slept a night within a hundred yards or so of the cañon into which the river plunges; a fact which is not so surprising as it at first appears in view of the extraordinary labyrinth of ravines and side channels amidst which the cataract is situated, and through which it is most difficult to find one's way unless accompanied by a guide who is thoroughly conversant with the locality.

Yet another missionary, Livingstone's father-in-law, James Moffat, was near the falls in 1818, six years before Thompson, and made an effort to see them, but likewise came away without doing so though he heard the roar of the water. "Feeling excessively tired," he writes, "I sat down under the shadow of a bush and was soon fast asleep." On being awakened by his followers, he heard another roaring, to wit that of lions, and finally turned aside from the direction of the river altogether.

The first white man to see the Aughrabies, as far as is known, was a certain Jacob Hendrik Wikar, a soldier who is said to have been a deserter from the East India Company and who originally hailed from Gotteburg. On a ride through the region he came upon the falls in September, 1778, and again visited them in May of the following year. The report of them which he made to Baron van Plettenberg, the then Governor of the Cape of Good Hope, will be found in the *Linschoten Vereeniging Publication*, 1916—*Reizen in Zuid-Afrika II. Tochten naar het Noorden*, 1688–1800.

"From Namis," he writes, "it is about two hours' walking to the river, where the Great Cataract is found which can be seen from a very long distance, even further than a column of smoke can be observed. To me it appeared as if the whole river dropped over a stone ridge, twice the height of the castle, but I observed it again in the winter month of May when the spray did not rise to the same height as in the dry season in clear weather. Much depends upon the quantity of water in the river, and the weather condition has much to do with it. Sometimes the noise can be heard from a great distance, like the rolling of the sea. Half an hour above this waterfall the stream is very strong; the Namnykoa told me that if by accident the hippos get into midstream they are carried downstream and washed over the waterfall and break their backs. They are then easily caught by the Hottentots. Also a few years ago a number of cattle were driven through the river half an hour above the waterfall and quite half the herd was washed down. Below this waterfall, when the river is low, the Hottentots generally catch large quantities of fish," etc.

Appended to the above description is the following Editor's note:

"This is the 'Great Waterfall or Cataract in the Orange River,' a picture of which may be seen in the Gordon Collection, No. 64, and referred to in the description of No. 42—'View of the Country on the 28th degree, 32 min. South, 3 degrees East long. of the Cape of Good Hope, below the Great Waterfall Aukoerebis, in the Orange River, or Gariep, in Einiquasland.'"

And he adds: "With that (i.e. accompanying the picture), it is stated—'There I experienced the most unique and wonderful view of all my travels, getting a sight of animals in a crescent, of twelve zebras, fifty elephants, five rhino, twenty ostriches, thirteen kudus and a great number of zebras, while hippos were disporting themselves in the river below.'"

Whether this picture in the Gordon Collection at the Hague is by the hand of Wikar or another is not stated, but presumably it was in existence well before 1806, and most probably before 1800. The account which accompanies it of the game that was then to be seen is extremely interesting as showing to what an extent conditions have altered at the present day when, largely owing to the increasing desiccation and aridity of the whole region, the animals named seem to have entirely vanished.

The fact, by the way, that George Thompson was not, after all, the original discoverer of the falls deprives of its force the plea which has sometimes been put forward that the original Koranna name *Aughrabies* should be superseded by that of *King George's Cataract*. In any event, as has well been pointed out, the former name, meaning "Big Waters," is the more euphonious, and further, it perpetuates the memory of one of South Africa's native races which has nearly disappeared.

Thompson's account, which is the first in English, appeared in his book *Travels and Adventures in Southern Africa*, published in 1827. At the time of his visit the Orange, or Gariep as he also calls it, was "at its lowest ebb and only about 500 yards in breadth; but," he adds, "the numerous vestiges of its overflowings extended over each bank at least a mile from the margin of the water and at some places to three and four times that distance."

After describing how, accompanied by a few Korannas, he had to cross a separate and southern branch of the river, then at very low water, in order to approach the main channel which forms the cataract, he continues:

"At length we reached a ridge of rocks, and found it necessary to dismount and follow our guides on foot. It seemed as if we were now entering the untrodden vestibule of one of Nature's most sublime temples; and the untutored savages who guided us evinced by the awe and circumspection with which they trod that they were not altogether uninfluenced by the *genius loci*. They repeatedly requested me to keep behind and follow them softly, for the precipices were dangerous for the feet of men—and the sight and sound of the cataract were so fearful, that they themselves regarded the place with awe, and ventured but seldom to visit it.

"At length the whole of them halted, and desired me to do the same. One of them stepped forward to the brink of the precipice, and having looked cautiously over, beckoned to me to advance. I did so, and witnessed a curious and striking scene; but it was not yet the waterfall. It was a rapid formed by almost the whole volume of the river, compressed into a narrow channel of not more than 50 yards in breadth, whence it descended at an angle of nearly 45 degrees, and rushing tumultuously through a black and crooked chasm among the rocks, of frightful depth, escaped in a torrent of foam. . . . They now pioneered the way for about a mile farther along the rocks, some of them keeping near, and continually cautioning me to look to my feet, as a single step might precipitate me into the raging abyss of waters—the tumult of which seemed to shake even the solid rocks around us.

"At length we halted as before, and the next moment I was led to a projecting rock, where a scene burst upon me far surpassing my most sanguine expectations. The whole water of the river (except what escapes by the subsidiary channel we had crossed and by a similar one on the northern side) being previously confined to a bed of scarcely 100 feet in breadth, descends at once in a magnificent cascade of fully 400 feet in height. I stood upon a cliff nearly level with the top of the fall, and directly in front of it. The beams of the evening sun fell full upon the cascade, and occasioned a most splendid rainbow; while the vapoury mists arising from the broken waters, the bright green woods which hung from the surrounding cliffs, the astonishing roar of the waterfall, and the tumultuous boiling and whirling of the stream below, striving to escape along its deep, dark, and narrow path, formed altogether a combination of beauty and grandeur such as I had never before witnessed.

" As I gazed on this stupendous scene I felt as if in a dream. The sublimity of Nature drowned all apprehensions of danger; and after a short pause, I hastily left the spot where I stood, to gain a nearer view from a cliff that more immediately impended over the foaming gulf. I had just reached this station when I felt myself grasped all at once by four Korannas, who simultaneously seized hold of me by the arms and legs. My first impression was that they were going to hurl me over the precipice; but it was a momentary thought, and it wronged the friendly savages. They are themselves a timid race; and they were alarmed lest my temerity should lead me into danger. They hurried me back from the brink, and then explained their motive, and asked my forgiveness. . . . The river, after pouring itself out in this beautiful cascade rushes along in a narrow chasm or canal, of about 2 miles in length, and nearly 500 feet in depth, apparently worn in the solid rock, in the course of ages, by the force of the current.

" In the summer season, when the river is in flood, the fall must be infinitely more magnificent; but it is probably at that time altogether inaccessible; for it is evident that the mass of waters, unable to escape by this passage, then pour themselves out by mighty streams by the two subsidiary channels, which were now almost dry, and at the same time overflow nearly all the entire tract of forest land between them—which forms, at other seasons, a kind of island, as we now found it. I named this scene ' King George's Cataract,' in honour of our gracious Sovereign."

It is interesting to compare the above account, written over a hundred years ago, with the impressions of modern visitors, as Thompson's description would seem to indicate that there was considerably more vegetation right at the falls themselves in his day than in our own time, which again goes to confirm that the whole region, except where irrigation has been recently introduced, has become increasingly arid with the passing of the years.

This, also, is borne out by the impression he gives that, though the river was "at its lowest ebb," a quite considerable body of water was passing over the falls; whereas to-day, at dead low water, they are reduced to a thin feathery stream, quite incapable, at such a time, of emitting the "astonishing roar" to which he alludes.

The headstreams of the Orange River, of which the chief is the Senku, have their sources high up in the wonderful region of the Drakensberg Mountains, where some 20,000 acres have now been allocated as the nucleus of a great National Park. As I looked at the infant stream commencing its long journey 10,000 feet up and more on the slopes of Mont aux Sources, and not more, as the crow flies, than 130 miles from the Indian Ocean, it was difficult to realise that it was this same stream which I had already seen but a few weeks previously roaring into the mighty cañon of the Aughrabies and in whose surging waters I had nearly been swept away. I shall return to the Mont aux Sources later on, for here the youthful Tugela commences its descent to the plains with a series of leaps totalling no less than 2810 feet.

In the same way that the Rio São Francisco starts its career with a fine cascade in the shape of the Casca d'Anta, so, too, one of the main feeders of the Orange, the Maletsunyane, has a magnificent fall, known by the same name, of which the height is variously estimated to be between 630 and 660 feet in a sheer leap. Were it situated in Scandinavia, there is little doubt, so grim and eerie are its surroundings, that the Vikings of old would have regarded this fall as being especially the haunt of trolls and demons.

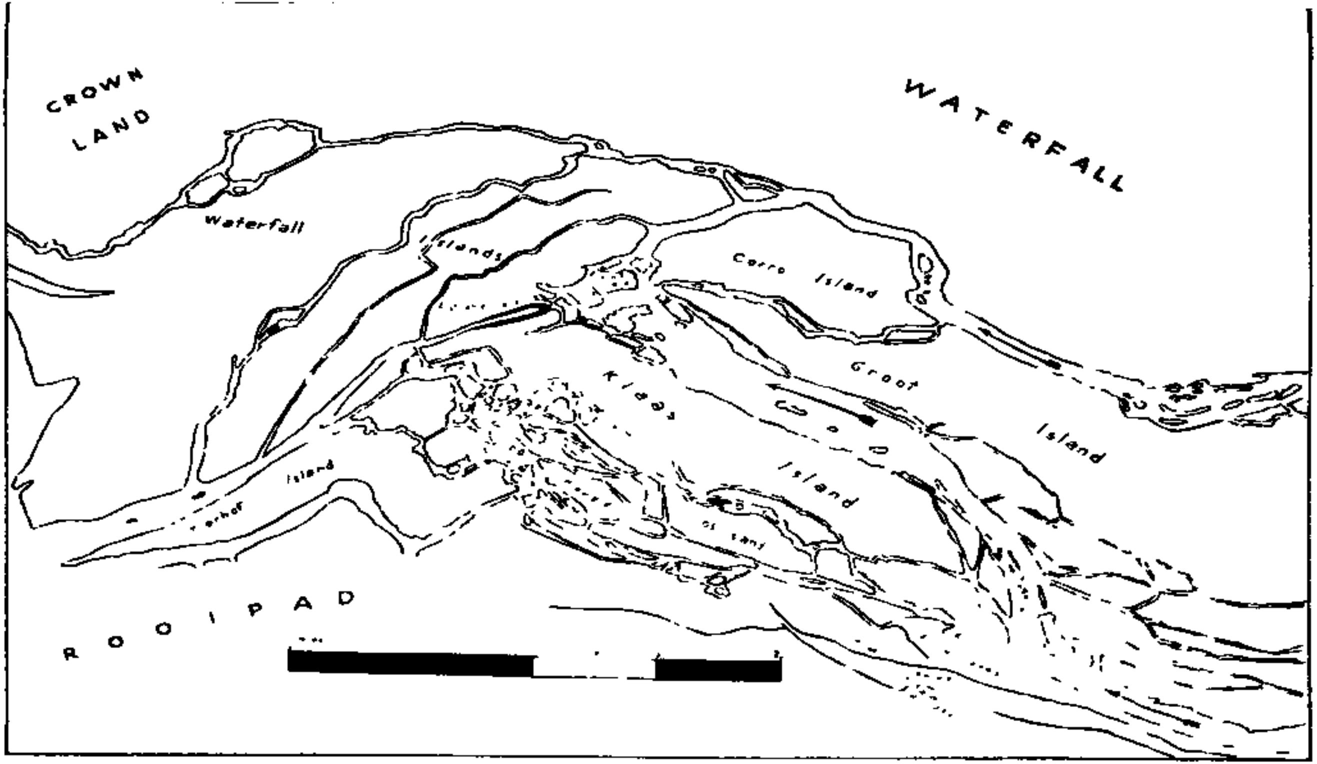
Major E. A. T. Dutton records that the cauldron into which it plunges is shunned by the Basutos as "the retreat of noxious reptiles and evil spirits"; and the late Sir Godfrey Lagden in his book, *The Basutos*, further says that they fear to approach the brink of the cataract. "Below these falls," he writes, ". . . is a world of the weirdest description where the solitary wanderer experiences a sense of awe, for he feels almost to have sunk into the bowels of the earth. The mighty rush of water from above, after floods, has cleft the ground asunder, and, quickening its course downwards through innumerable channels, has left gigantic pillars which in fantastic shape stand there frowning, and threatening to fall upon the observer if he but stares at them."

The total length of the Orange is, roughly, 1300 miles, of which it has traversed over 900 at the point where the great falls occur, the latter being situated from 350 to 360 miles upstream from its mouth. There is little doubt that in years gone by it was a far mightier stream than it is to-day. Indeed, the volume of the Proto-Orange, as the late Professor Schwarz termed it, must have been immense; and in those days Aughrabies may well have approached Niagara in the volume of even its mean flow, besides being as well far more than double the latter's height. The bed of the river all the way down from Upington, over 80 miles above the falls, may be compared to a huge inland delta, varying in width from one to as much as five miles, and strewn with a maze of jungle-clad islands, some of which, such as Cannon Island, some 20 miles below Upington and 11 miles in length, are of considerable size.

The soil on some of these islands, and as well on the river-banks, is immensely rich, being in places 40 feet in depth, and many of them are now intensely cultivated. The small township of Kakamas, 27 miles above the falls on the south bank of the river, affords a notable instance of what can be accomplished by irrigation even on a small scale. This settlement was originally founded as a colony for poor whites by the Dutch Reformed Church in 1897, and now numbers well over 3000 persons who have cultivated an area on that side of the river of about 35 miles in length by 10 in width. It has become a great citrus centre and, as well, produces an abundance of excellent sultanas. There are also flourishing orange gardens, and tobacco, potatoes, lucerne, wheat, mealies, pears, plums, apricots and apples, etc., grow in profusion.

The reader must not deduce, however, from the example of Kakamas that, generally speaking, the lands bordering the Orange lend themselves to irrigation on any extensive scale. Unlike the Nile or the Ganges, the Orange, to quote Mr. A. D. Lewis, Director of Irrigation for the Union Government, "has always been a powerful eroder, never a builder of lands," and for various reasons, too long to set out here, but which will be found in Appendix No. 1 of Mr. Lewis' Report (Union Government Publication No. 9 of 1930) no schemes of large-scale cultivation, that is, of 100,000 acres and more, have been found feasible, while even medium-sized schemes for irrigating 10,000 to 15,000 acres are extremely limited in number when regarded as economic possibilities.

Before describing my own visit to the Aughrabies Falls I must first try to convey to the reader the nature of their immediate



MAP, COMPILED FROM AIR VIEWS, OF A SECTION OF THE ORANGE RIVER AT THE AUGHRABIES FALLS

surroundings and formation. The map here reproduced by kind permission of Mr. Lewis was recently made from a series of air views, taken towards the end of February, 1934, and at a time when the river had much declined below its maximum flood, which that year reached its peak at 263,000 cusecs on or about January 10th. The air view here shown of the fall itself, for which I am indebted to General Sir Pierre Van Ryneveld, was also taken at the end of that same February at 700 feet altitude. At low water many of the smaller side channels shown on the map are quite dry, and, further, it is on too extended a scale to indicate in detail the gullies and the upper cañon, of which I shall speak later, which lie just above the actual fall.

As will be seen, the Farm Rooipad, which has belonged to Mr. Ben Nel and his brothers, as also to their father before them, for many years past, lies on the south bank of the river. It comprises nearly 150,000 acres and formerly included the falls themselves. The latter were acquired, however, by the Union Government some years ago. Opposite Rooipad the Orange, from one true bank to the other, is fully 4 miles wide and, some distance above the farm, it splits into three main branches: a southern branch, a central branch and a northern one. The first, which is almost dry at comparatively low water, again subdivides lower down into a considerable number of smaller channels, and, at any stage, contributes but little to the great fall.

The bulk of its waters pass down into the Main or Grand Cañon below the falls through two subsidiary and narrow cañons, and, for a considerable distance, entirely disappear underground. The exit of the more northern of these cañons opens out on to an immense flat slab of granite, the edge of which is perhaps 150 feet above the bottom of the Grand Cañon, and over which the stream when high forms what must be a very fine additional waterfall, though when I saw it very little water was pouring over it. I may here remark that in the opinion of Mr. Ben Nel, than whom no living man knows the Orange better in all its stages, fully 95 per cent or more of the total water of the river passes over the great fall at normal flow, and probably quite 80 per cent of it when in high flood.

The farther side of this southern branch is bounded here by a large island known as Klass, or Ouklass, Island, which has lately loomed much in South Africa's public eye as it is across to this island that it has been proposed to build a bridge to enable visitors to gain access to the falls at flood time, which is quite impossible at present unless one is prepared to swim for it, no matter whether one approaches the cataract from the south or the north bank. In any event no approach from the north bank is possible at all at high water. This bridge would lead to a long ridge which extends for nearly the whole length of Klass Island to a point on the rim of the Grand Cañon a little below the fall and commanding a good view of it, and it is always above flood water. It has never been proposed, as has been stated by ill-informed journalists, to build any bridge across the Grand Cañon itself just below the falls ; but even this bridge over the southern channel would have to be at least 900 yards in length to be above the rise of the river.

Along the ridge above mentioned it has further been proposed to make a rough track which cars could negotiate. Colonel the Hon. Deneys Reitz, M.P., now Minister of Lands for the Union Government, is particularly interested in this scheme, for which a sum of £4000 has already been ear-marked. The amount was found to be quite inadequate, however, with the result that the project has been shelved for the time being, though meanwhile Mr. Ben Nel himself is undertaking to provide a ferry and a steel cable which will temporarily serve the purpose.

The second, or central branch, of the river lies between Klass Island and Groot Island, being there some 300 yards wide or more and strewn with enormous boulders. When in flood the whole of it is a raging torrent from bank to bank, but in the dry season the stream is confined to a narrow channel in the centre of the river-bed consisting of a succession of deep pools linked up by short rapids. As it nears the fall all the waters of this central branch are compressed into a narrow, steeply sloping gully, down which they surge to the entrance to the upper cañon which conducts the whole river, except, as has been said, the southern branch, to the crest of the fall. For at this point also, that is at the entrance to this upper cañon, four further similar gullies bring down the bulk of the waters of the last and northern branch of the river, which carries by far its largest portion. Three of the latter descend at right-angles to the one bearing the stream from the central branch, while a fourth gully makes a detour, and then, bending around in an opposite direction to the rest of the river, descends also at right-angles to the other three and immediately facing the gully from the central branch.

All converge at these opposing angles at the entrance to the upper cañon, where there is consequently a tremendous clash

Photo by the Photographic and Air Survey Section of the South African Air Force, by courtesy of General Sir Pierre Van Ryneveld

AN AIR VIEW OF THE AUGHRABIES FALLS TAKEN AT 7,000 FEET ALTITUDE.

THE AUGHRABIES FALLS

(*Above*) Two of the gullies leading to the Upper Cañon. (*Below*) The Crest of the Main Fall.

From a photo by Mr. P. C. R. Scott Hayes

and turmoil of waters. Mr. Bertus Nel, who, as I shall mention later, is the only living man who saw the falls at the peak of the great flood of 1925 tells me that on that occasion the scene here was quite indescribable, masses, not of spray, but of solid water, being hurled up into the air for 50 or 60 feet and more, as if caused by violent subaqueous explosions. It is an offshoot from this turn-about gully which feeds the small additional fall that pours over the northern rim of the Grand Cañon a little below the main fall. This small fall is not, by the way, shown on the map. Other overflowings, also from the northern branch of the river, pass by the main fall and, at ordinary flow, form some three or four minor falls at points lower down the Grand Cañon, of which the correct length is approximately 6 miles.

The upper cañon, to which I have referred, is about 200 yards in length with a very sharp turn, known as the Elbow Bend, half-way down it. Its walls, as far as I could judge, are from 30 to 40 feet high at the entrance, increasing to perhaps 60 or 70 at its exit. Just below the Elbow Bend they are less than 100 feet apart at the upper rims and not more than about 25 feet at water level. It has also been suggested to bridge the upper cañon at this point so as to allow visitors to cross from the southern to the northern side, or vice versa, and thus avoid having to go all the way back to Kakamas if wishing to view the falls from both banks.

The combined stream, surging down the upper cañon, hurls itself violently against the southern wall at the Elbow Bend, then, swirling around the corner and dropping quite 30 feet or more over a succession of rocky bars like huge steps, it shoots out with immense depth and velocity for fully 450 feet into the Grand Cañon below, thus forming the Great Aughrabies Falls.

As will be gathered from the above brief description, most visitors to the falls see them from the north or south bank only, making their headquarters at Kakamas, where the last bridge crosses the river, and motoring down to the vicinity of the cataract over very rough tracks along either side of the Orange. Thence, if the state of the river permits, they have to wade across to the northern or southern edge of the Grand Cañon as the case may be.

With the possible exception of one or two local residents, I believe I am the only person up to that time—certainly the only visitor—ever to have crossed the Orange at its then stage entirely from the south to the north bank in the immediate vicinity of the falls, and thus to have seen them from both sides without having to have recourse to the Kakamas Bridge. It is an undertaking which, as the sequel will show, I should certainly not recommend to anyone who is not a strong swimmer and well accustomed to battling with rapids.

Through the good offices of my friends, Mr. Louis Kraft and Mr. Scott Hayward, who made the first film of the falls in the summer of 1934, I was fortunate in getting an introduction to Mr. Ben Nel, who luckily happened to pay a flying visit to Cape Town shortly before I had arranged to start on my trip. Mr. Nel not only acted as my guide to the falls, but with his brother and sister-in-law, Mr. and Mrs. Bertus Nel, he most kindly made me his guest at Rooipad during my four days' stay in the neighbourhood. This saved me much time and inconvenience, as the only other alternatives would have been to camp out, or to put up at the boarding establishment at Kakamas 27 miles upstream.

Rooipad Farm is from 2½ to 3 miles above the falls in a direct line, but the circuitous route one has to follow to get to them makes the distance a good deal longer—no great distance, it is true, but preferably to be avoided in the middle of the day when the temperature may be easily from 110 to 115 degrees in the shade, not to speak of a hot wind blowing from the nearby Kalahari, which dries one up as if it were belched out from an oven.

On my first morning, instead of doing the obvious thing and making for the south side of the cañon, I decided to attempt to see the falls from the northern side, whence, as a matter of fact, the view is a much more complete one. It was then about the middle of February, and the river was lower than usual for the time of year. We crossed the almost empty bed of the southern branch practically dry-shod, while a swim of a few yards only through one of the deep pools in the central branch presented little difficulty.

From descriptions by previous visitors I had been prepared to find this section of the river so near the falls a labyrinth of bare granite rocks and islets without a vestige of vegetation or animal life ; but, on the contrary, I found the islands quite thickly clad with jungle growth, among which camel-thorns, mimosas, raisin trees, euphorbias and the wild tobacco plant were conspicuous. There was also plenty of bird life ; and I noticed in particular two enormous owls and several large birds with black plumage and red bills, like a species of heron, who stood perched on the granite rocks watching us solemnly. Now and again, too, we had glimpses of a troupe of black-faced monkeys ; and, later on, we saw several baboons among the rocks bordering the Grand Cañon below the falls.

What struck me most forcibly, however, in crossing those then depleted channels was the manifest indication of the river's stupendous and incredible volume in flood time. I noticed here and there masses of driftwood piled fully 30 to 40 feet up among the trees, and, lower down, even above the 70-foot wall of the upper cañon I saw huge pot-holes scoured and eroded by the force of the water. No one who has not crossed these channels at low water can form any conception of what the Orange can be like in a really big flood.

In spite of the intolerable heat, our progress had so far been easy, but it was when we came to the farther side of Groot Island, bordering the northern branch of the river, that our difficulties began. Here the main bulk of the Orange, perhaps 10,000 to 12,000 cusecs at the time, was pouring down in a succession of deep and strong rapids, which it was necessary to cross somehow before we could gain one of a group of islands, known as Waterval Islands, and thence, after crossing one farther narrow channel, gain access to the northern edge of the Grand Cañon and so view the falls from that side. It was not so much the rapid itself, some 40 to 50 yards across, that gave me qualms of apprehension, but the fact that the entrance to one of the narrow gullies, which conduct the waters of the northern branch to the upper cañon, lay only about 160 yards below us.

To cut a moving story short, Mr. Nel, with my camera and his shoes tied around his hat, essayed the passage first, while I watched him from the bank, and, after a stiff struggle, he gained the farther shore. I plunged in and followed him ; but when I was almost across, being indeed within two yards of still water on the other side, I was suddenly swept back by some eddy into midstream again and carried down like a cork towards the entrance to the gully. For a moment or two I thought I was lost. The velocity and depth of the current were great, and I seemed powerless to get out of it. Luckily, about 100 yards lower down, two small rocks jutted out of the torrent towards the bank from which we had started. I made a desperate effort to get to them, and succeeded finally in reaching the lower one of the two and hauled myself on to it. There were still, however, several yards of swirling water between me and the bank.

Mr. Nel, who had watched these proceedings with some concern, shouted across to me, but the roar of the water prevented my hearing a word he said. Then, signing to me to stay where I was, a direction with which I may say I felt entirely in agreement, he pluckily plunged in again and made towards me. For a few moments the speed with which he was carried down made me fear that he would be swept past me, but eventually he, too, gained the rock and joined me upon it. It was, as he then observed, quite the worst place I could have made for, but his arrival renewed my confidence, and after a minute or two we again plunged in together and managed to get back to the bank we had originally started from.

After this experience I did not care to attempt a crossing at that particular spot again ; it was too unpleasantly close to the gully. I was not, however, to be balked of my objective, so finally we walked through the thick jungle to another point about a quarter of a mile upstream. Here again we were faced with a deep and strong rapid, but with the aid of a floating log, of which there was none lying around where we had made our first attempt, we managed to reach the farther bank without much difficulty. It was on re-crossing at this same spot, by the way, after I had seen the falls, that my camera, with the snaps I had taken, slipped off Mr. Nel's head and was unfortunately lost beyond recovery.

We had still to make one more crossing between the island on which we had landed and the rocky ground giving on to the edge of the Grand Cañon. This was the stream which, just below, flowed down the gully that I have described as bending around in a reverse direction to the rest of the river. It was narrow and very deep, but the water was still where we crossed it, though less than 20 yards further down it commenced its roaring descent to converge with the others at the entrance to the upper cañon. This accomplished, I at length gained my first view of the falls from the rim of the Grand Cañon on its northern side.

The cañon at this point is known to be over 500 feet in depth, and my own observations agree with those of others in estimating the crest of the fall to be some 50 feet below its rims, thus making the drop about 450 feet. If, however, one reckons the fall to commence where the river begins to cascade down below the Elbow Bend, the total height cannot be much less than 480 feet, if not rather more. Mr. Lewis reckons the drop to be 485 feet, " in a very short distance." Assuming it, however, to be 480 feet the Aughrabies is thus 126 feet higher than the maximum drop of the Victoria Falls, which, according to the latest survey

Photo by Mr. F. C. [illegible] Hazzard

THE CAÑON BELOW THE AUGHRABIES FALLS

It extends for over 6 miles and is approximately [illegible] feet in depth.

made by the Northern Rhodesian Government in October, 1934, is 354 feet.

It is the velocity and dense mass of the turgid brown column falling with a dull roar into this titanic and arid cleft that most impresses one at the first glance. The epithet "awe-inspiring" has been much abused, but I can think of none better here. The fall is not quite unbroken. At dead low water a huge pot-hole can be seen in the face of the rock some 150 feet down, but now the descending column, casting out spume and comet-like masses of amber foam as it thundered down, was sufficiently dense to conceal it, giving the whole the appearance of a single, mighty leap. From this concealed pit and from the pool far below, of which 140 feet of weighted line has failed to plumb the depth, clouds of white spray and tongues of swirling vapour were constantly shot aloft with amazing violence for 200 feet and more, cloaking the lower part of the fall. The Aughrabies is not beautiful like the Victoria Falls, but it is terrible and intensely impressive; and the whole effect is heightened by the savage aspect of the cañon itself, whose walls, scarred and riven and sheer, seem to have been cleft asunder by some appalling lightning-stroke.

On subsequent days I viewed the falls from the south side where they were first quite easy of access, but on my final visit the river had risen considerably, and quite a strong stream was flowing down the southern branch, over which we waded, at times more than waist-deep, at a point below Rooipad Farm, where it subdivides into a number of minor channels, all of which we had to cross. The beds of these channels are strewn with submerged rocks against which one is apt to bark one's shins, as it is quite impossible to see them beneath the thick, chocolate-coloured water. Among the huge rocks near the rim of the cañon on this southern side I noticed, by the way, the most brilliantly coloured lizards I had ever seen, with greenish blue heads and bodies slashed with vivid scarlet.

Dr. Lawrence, the naturalist, who accompanied Mr. Kraft when the latter filmed the falls in 1934, told him that they were a very rare species and he was astonished to find them in such numbers here. I observed that the increased volume of the river did not greatly change the face of the fall itself, so deep is the recess at its crest over which the torrent hurtles. It is a matter of no difficulty at all to clamber down to the very brink on this side and to proceed along a flat shelf of rock, submerged, of course, at high water, known as "The Platform," which extends a little way into the upper cañon towards the Elbow Bend. The close proximity of the surging mass of water, however, might well affect the nervous-minded. As the Korannas warned George Thompson, one has to look well to one's feet, for a slip here would be fatal.

The falls are most deceptive to the eye as in their setting of stark rock, combined with the absence of any trees at their edge, there is no scale of measurement by which one can grasp their true height, and at the first glance they appear of less magnitude than they actually are. Huge boulders on the further side of the cañon, which is here over 300 yards across from one rim to the other, appear, for instance, to be perhaps from 6 to 10 feet high, whereas they are from 30 to 50 in reality. Far below, the discoloured band at the river's edge, marking the rise of the flood waters, seems no wider than a narrow tape, and it is only when one learns that it is from 40 to 60 feet in breadth that one begins to appraise correctly the cañon's depth. Generally speaking, I should judge that it is also much wider at the water's edge than is the cañon of the Zambesi below the Victoria Falls.

For about 800 yards below the foot of the fall the river is comparatively tranquil, and indeed at low water forms a long, still pool before a mass of boulders obstruct its course, causing it to break again into rapids. It was from the lower end of this pool, where a curious detached pillar of rock projects itself upwards from below the northern rim of the cañon that Colonel Reitz, having managed to climb down to the water's edge, once swam up to the foot of the fall at very low water. He tells me that masses of driftwood were floating down on one side of the river and being carried up again towards the fall on the other, and that by following them on their upward trend he did not find the feat a difficult one.

Mr. Nel has also managed to get a raft or canoe down to this pool on more than one occasion and to go right up to the base of the fall, of course when the river was low. On one of these occasions he had the melancholy task of trying to find the body of an unfortunate store-keeper named Poggenpoel, who had slipped at the brink of the fall while stooping down to drink and had fallen over. Though Mr. Nel dredged the pool with a weighted line of 140 feet, he failed, in places, to plumb its depths or to find the body. The latter was some time afterwards, however, recovered, not from the pool but from the large pot-hole which I have mentioned as indenting the face of the fall some 150 feet down from its crest.

[illegible]

THE AUGHRABIES FALLS FROM THE SOUTH BANK

An idea of the height (4[illegible] feet) may be gained from the human figure [illegible] over the edge of the rock on the right of the [illegible]

When Mr. Louis Kraft and Mr. Scott Hayward filmed the fall, for the first time, in 1934, the former was suspended by an Alpine rope and a steel wire over the edge of the huge boulder at the crest on the southern side, a position I should not much have cared to occupy myself. In the view of the Main Fall he can just be seen hanging over the edge of the rock, while higher up Mr. Nel is controlling the rope. This photograph, which is one of the very few which gives an idea of the height of the falls in comparison with the human figures, was taken by Mr. Scott Hayward at about 300 yards distance.

The suggestion to build the bridge over the southern branch of the river to Klass Island has lately drawn much attention to the Aughrabies Falls, and they have been the subject of many articles in various South African journals which have contained a great many inaccuracies and misstatements. One writer, for instance, who evidently had not seen them, described them as a series of cataracts rather than as " waterfalls in the strict sense " ; while another emphasised, as if it were something stupendous, that 28,000 gallons per minute passed over the falls on an average for every minute of the year, not in the least being aware that this ridiculous figure would be equivalent to no more than about 60 cusecs ! Yet another scribe gave the depth of the cañon as being only 200 feet, though, a line or two further on, he quoted the height of the falls correctly at 480 feet !

The old account of G. A. Farini, who visited the Aughrabies in the early eighties of the last century, which is the one usually quoted even to-day in various encyclopædias, whose editors evidently do not trouble to get up-to-date information about these or any other falls but dish up the same inaccuracies in edition after edition, is also very incorrect. He states that the Grand Cañon is 16 miles long (whereas it is 6), and claims to have seen no less than 100 separate falls. At normal flow there are no more than four or five minor falls apart from the main one, and had there been anything like the number Farini stated it is fairly safe to say that he could never have crossed the side channels to get to the main cañon at all unless he had been a most exceptional swimmer.

Two facts can be stated about the Aughrabies which are not generally realised. First, it is the highest fall in the world which occurs on a major or first-class river ; and secondly, that height combined with its immense flood volume makes it, at those periods, one of the greatest. Apart, of course, from Guayra and the Khon Cataracts, I can think of only two other falls whose extreme flood discharges may, at times, be greater, namely Paulo Affonso and the falls on the Cauvery at Sivasamudram, but neither of these is nearly as high.

The mean annual volume of the Orange according to readings on the gauge at the Buchuberg Dam, some 162 miles above the Aughrabies, is approximately 8,000,000 acre-feet, or about 11,050 cusecs. There is, of course, a certain amount of loss through evaporation between the dam and the falls, but Mr. G. T. Ritchie, Circle Engineer of the Lower Orange River Circle, tells me that when the river is high such loss would be practically negligible. The variation in flow is enormous, greater perhaps than that of any other river in the world. At dead low water, which generally occurs in August and September, the discharge may sink to only 100 cusecs and, on occasions, almost cease altogether. But at its maximum flow, in the opinion of both Mr. Ritchie and Mr. Lewis, the volume may rise to the enormous amount of no less than 500,000 cusecs; that is more than double the mean flow of Niagara with 75,000 cusecs to spare, and more than thirteen times the mean of the Victoria Falls which, according to Dr. du Toit's figures, is 38,430.

My own observations, while noting the débris left by high floods when I crossed the river-bed, lead me to believe that this estimate of 500,000 cusecs would be by no means excessive. It is also confirmed by the figures given for the maximum discharge of the river at Orange River Station by Mr. F. E. Kanthack, C.M.G., in his book, *The Principles of Irrigation Engineering with special reference to South Africa* (1924), who quotes 281,000; this, be it noted, being well above the junction of the Vaal River, which, at such times, would certainly contribute an equal or even greater amount, not to mention other tributaries as well. There is little doubt, I imagine, that in the great flood of 1925 the discharge of the Orange at Buchuberg reached this high figure of 500,000 cusecs; while there is a local tradition that in 1860 the flood waters rose even 20 to 25 feet higher.

The flood rises of the Orange, unlike those of the Zambesi, are sudden and irregular in the extreme and occur from November to April. Thus on or about November 20th, 1933, the flow was almost at zero. By the 2nd or 3rd of December it jumped up to 140,000 cusecs. In the middle of the same month it had sunk again to 16,000; and then about January 10th, 1934, it reached its peak, for that season, of 263,000, and again, after lesser variations, subsided to 8000 at the end of April. It was at the time of its maximum flow that Colonel Reitz flew over the falls in an aeroplane, but the photograph he took of them did not, unfortunately, turn out very satisfactory. The air view here reproduced was taken, as I have mentioned, about the end of the following February when the river had very greatly subsided. The speed of the flood water, filling up pools and side-channels as it proceeds, averages about 36 miles in twenty-four hours.

From the boundary between Kameelpoort and Uizip down to below the Aughrabies Falls, a distance of 95 miles including the whole stretch of the river called by Mr. Lewis "The Island Reach," the total drop is 1130 feet which, apart from the great fall, includes three minor drops at Keimoes, Friarsdale and Neus. Below the Grand Cañon the Orange is far more sluggish and its descent averages only 4 feet per mile.

The only living man who has seen the Aughrabies at its maximum flood, namely in 1925, is Mr. Bertus Nel, a man of exceptional physique and an extraordinarily strong swimmer. At the time when the river was rising, he swam a distance of 2 miles from Rooipad to Klass Island in order to rescue some of his sheep from the low-lying islands and to bring them on to higher ground above the flood waters. This he succeeded in doing, and he spent the night on the Klass Island ridge by the southern rim of the cañon near the falls.

The next morning the flood had reached its peak. He tells me that the scene was one that only the gods could have depicted. The whole of the upper cañon was full to the brim, with the raging flood overflowing its northern edge; while in addition to the stupendous mass, anything from 50 to 100 feet deep, passing over the crest of the fall, the high northern wall of the Grand Cañon itself, to an extent of fully 500 yards, had an immense additional and undivided cataract roaring over it, not a single crag being visible above the flood.

I am told that at high water the roar of the falls can be heard 36 miles away, and that at such times a great white cloud can be seen high in the sky above their crest. The rise of the flood water in the Grand Cañon may be 40 to 60 feet, and probably more; but as the water at the brink of the falls also rises immensely, the total drop, measured from the surface of the water above to that of the pool below, is not, probably, very greatly lessened.

One of the most striking modern accounts of the falls is by the late Lieutenant F. C. Cornell, O.B.E., in his book, *The Glamour of Prospecting*, though he is rather inclined to exaggerate the desolation and lifelessness of their surroundings. "On all sides," he writes, "nothing but riven, shattered rock, sheer precipice and giant buttress, a nightmare of barrenness, of desolation so appalling that one might well be standing in some other planet, some dead world from which all sign of life had long since vanished."

Cornell, by the way, has been largely responsible for the propagation of mythical stories about the neighbourhood of the falls which have caused many people to waste much of their own time and that of Mr. Ben Nel as well. Thus there was said to be a wonderful "Diamond Hole" stacked with waggon loads of the precious gems, and a "Lost Valley" where they were also to be found in abundance. Mr. Nel, who has known every yard of the surrounding country since childhood, emphatically contradicts these tales which have brought all kinds of treasure hunters to the falls, some even by aeroplane, who have pestered him with questions regarding them.

Then there is the legend of the monster snake, or the "Groote Slang," which is said to haunt the deep pools of the lower Orange below the falls and to carry off the Hottentots' sheep and cattle. Had the ancient Greeks been acquainted with the locality, the enormous and bizarre rocks, many of them fantastically shaped into semi-human lineaments, might well, indeed, have inclined them to believe that here Medusa the Gorgon had her secret and authentic lair. Cornell's tale of the snake, which might well have provided the late Sir Rider Haggard with a thrilling plot, was originally published in the now defunct journal, *The State of South Africa* (August, 1910), and may be repeated here. If he is to be credited, he came within an ace of making a personal acquaintance with the monster in question.

He relates that he was camping about 20 miles below the falls on the banks of the river with two companions, one of whom was a young American named Kammeyer. The Orange was coming down in spate, but as there was a quiet backwater nearby, Kammeyer elected to take a bathe in it. Some cattle, including a calf, were also grazing there at the water's edge. Cornell and his other friend watched Kammeyer splashing about, but presently, when their attention was momentarily diverted, they heard a smothered bellow from the calf and an awful cry of terror, and looked up to see Kammeyer staggering towards them, gibbering with fright, while the calf had entirely disappeared. On being somewhat restored with a stiff tot of brandy, the young American told the following extraordinary story, which he always afterwards stuck to; namely, that he was floating on his back in the pool when suddenly "a sort of wave surged up" quite close to him, and there emerged to a height of 10 or 12 feet out of the water the open-jawed head and tremendous body of a huge snake-like monster which suddenly pounced on the luckless calf and disappeared with it.

Kammeyer always stuck to his story that the Thing was no crocodile, but unquestionably a snake with a body as thick around as a barrel. Later, Cornell questioned the Hottentots in the neighbourhood, some of whom declared that they had seen it, and on one occasion had shot at it as it was making for some of their sheep up the river-bank; but the shots having no effect on the monster's progress, they not unwisely bolted and left the sheep to its mercies. Others who had not actually seen it, believed as a matter of course in its existence and declared that it left a trail on the mud flats a foot in width. In curious confirmation of his story, Cornell further quotes Sir James Edward Alexander, F.R.G.S., who was one of the first Englishmen to cross the river near its mouth in 1838 and who records in his book *An Expedition into the Interior of Africa*, etc.—"here an immense snake is occasionally seen whose trace on the sand is a foot broad."

Lieutenant Cornell expressed the opinion that possibly a new species of giant reptile might have its haunts here and be awaiting discovery. Mr. Nel, however, considers that this snake story probably originated from a very large "spoor" that may have been caused by otters playing in the mud. With that I must leave it.

A word may finally be said as to the means of getting to the Aughrabies Falls. The railway route is decidedly tiresome. The distance to Upington, for which one has to change at de Aar, 501 miles, is 759 miles. From there a narrow two-foot gauge line runs for a further 55 miles to Kakamas, the total distance to the latter point from Cape Town being thus 814 miles. This last 55 miles is usually traversed by a motor-rail bus in about three hours.

At the time of my visit, however, the bus was out of commission and was replaced by a Lilliputian train and a steam engine which took the appalling time of six hours and more to accomplish this short distance. This "Upington-Kakamas express," as it is derisively termed by the "locals," made three long stops by the way, for no apparent reason ; one of over an hour, and another of at least three-quarters. Its rate of progression, for the most part, was not much quicker than that of a brisk pedestrian. That apart, to get even as far as Upington one has the choice of two evils. One can take the Rhodesian express as far as de Aar, leaving Cape Town at 11.30 a.m. and arriving at de Aar at the unearthly hour of 4.10 a.m. the next morning ; in which event one has to wait there for seventeen hours, till 9.10 p.m. that evening, to get any train on to Upington. Or, alternatively, one can get a night train leaving Cape Town at 8.45 p.m. which arrives at de Aar at 7.48 the following evening, avoiding the long wait at the latter place, but taking over twenty-three hours to cover the 501 miles to get to it. If to the railway mileage to Kakamas we add the further 27 miles thence by road to the falls, their total distance from Cape Town by rail and road amounts to 841 miles.

On the other hand the distance by road from Cape Town to the Aughrabies or rather to Rooipad Farm, is no more than 484 miles, which can be, and has often been, traversed in a day, by making an early start, via Van Rhynsdorp, Niewondtville, Loeriesfontein and Granaatboskelk, etc. The motor car, therefore, is much to be preferred. But better still would it be to take an aeroplane. The distance in a direct line is less than 380 miles, so that it would be quite possible by leaving Cape Town early to spend the greater part of a day at the falls and be back the same evening.

A project has long been mooted, by the way, to widen the Upington-Kakamas line to the ordinary gauge, extend it to a point near the falls, and then to run it south to link up with the existing line going north from Cape Town to Bitterfontein ; but it seems doubtful whether this will ever become *un fait accompli*. Such a line, if ever made, would be a great boon to farmers through the region to be traversed, and would also save quite a day's railway journey to the falls.

CHAPTER XII

THE AFRICAN GIANTS: THE VICTORIA FALLS

WITHIN three days of my leaving the Aughrabies, I stood confronted with a widely different spectacle: the superb Victoria Falls on the Zambesi. Though the first account we have of these great falls is by David Livingstone, who came upon them in 1855, it is certain that they were known to Europeans, and seen by at least one person, namely, the Voortrekker, Louis Trichardt, before the date of his visit. The position of the cataract, indeed, had already been marked down on a manuscript map, dated 1852, by William Cotton Oswell, though the latter never actually saw it. It was Oswell, by the way, who took Livingstone with him on his first expedition to Lake Ngami.

But it is by no means improbable, though it cannot be proved, that the falls may have been seen well back in the previous century. In the library of the Parliament Buildings at Cape Town there hangs a map dated 1794 by S. Boulton, and printed by Messrs. Laurie and Whittle, then of 53 Fleet Street, London. This map is a copy of a much older Portuguese one which I understand can be seen in Lisbon, and on the Zambesi River thereon delineated there is quite clearly written the words "Great Cataract."

The late Sir George Cory, the historian, who first told me of this map, and Mr. Paul Ribbink, the librarian, to whom I am very much beholden for a copy of it, have no doubt at all that the words in question can refer only to the Victoria Falls; and those who dispute this have to account for the word "Great," which would hardly have been used had the description referred merely to rapids or to some minor descent of the river. This does not, of course, prove that the falls were actually *seen* by any Europeans at so early a date, but it does at least indicate that they were *known*, if only through native reports; a fact which in no way detracts from the glory of Livingstone's discovery, or re-discovery, as the case may be.

It is not by any means impossible that some priest, such as Father Silbeira, or another, may have visited the falls in the early eighteenth century; and it would be extremely interesting if an intensive search among Portuguese archives at Lisbon or elsewhere should bring to light some early description of them.

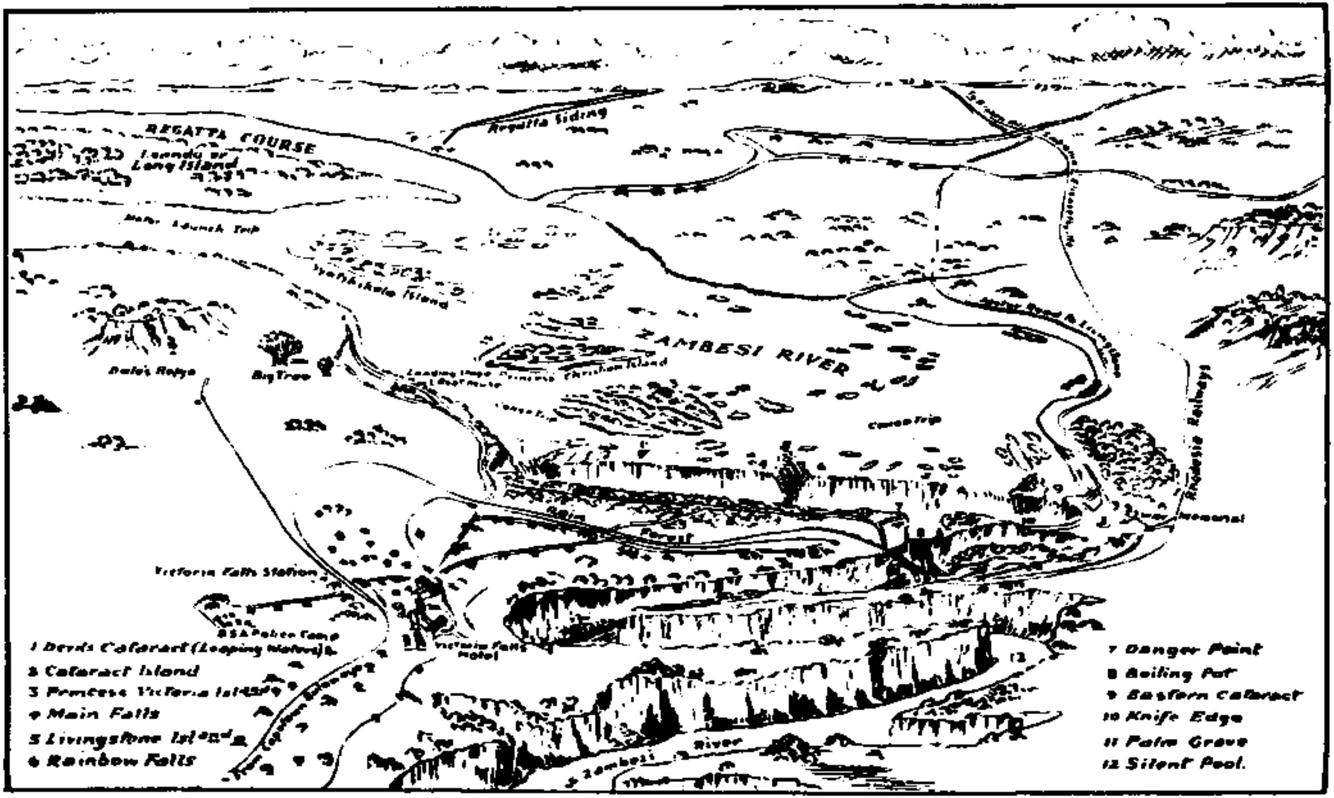
Livingstone's well-known account of his first view of what has sometimes, and not unjustly, been described as the Eighth Wonder of the World may be repeated here:

"When about a mile and a half from the falls," he writes, "I left the canoe in which we had come thus far, and embarked in a lighter one, with men well acquainted with the rapids who, by passing down the centre of the stream in the eddies and still places caused by many jutting rocks, brought me to an island situated in the middle of the river, and on the edge of the lip over which the water rolls. In coming hither there was danger of being swept down by the streams which rushed along on each side of the island; but the water was now low, and we sailed where it is totally impossible to go when the water is high. But though we had reached the island, and were within a few yards of the spot, a view from which would solve the whole problem, I believe that no one could perceive where the vast body of water went; it seemed to lose itself in the earth, the opposite lip of the fissure into which it disappeared being only 80 feet distant. At least I did not comprehend it until, creeping with awe to the verge, I peered down into a large rent which had been made from bank to bank of the broad Zambesi, and saw that a stream of 1000 yards broad, leaped down 100 feet, and then became suddenly compressed into a space of 15 or 20 yards. The entire falls are simply a crack made in a hard basaltic rock from the right to the left bank of the Zambesi, and then prolonged from the left bank away through 30 or 40 miles of hills."

The figures given above both for the width of the river and the height of the falls were subsequently found to be a good deal less than the reality. The orifice, also, is not prolonged from the left, or eastern bank, as Livingstone supposed, but occurs rather more than three-quarters of the way down the chasm towards it.

From its source to the point where the Victoria Falls occur, the Zambesi, according to different estimates, has traversed from 720 to 800 miles, and has already encountered two obstructions in the shape of the Sapuma Cataracts and the Gonye Falls. At the first it drops some 10 feet in a double leap, at the second, 300 miles lower down, it falls between 20 and 30 feet over a horse-shoe-shaped bar of rock in a seething mass of foam. From Gonye Falls it is another 100 miles to where the brown waters of the river, broadening out and interspersed with many forest-clad islands, approach the great chasm that yawns across its bed.

Above the falls there are no surging rapids preceding this great


REGATTA COURSE
Loando or Long Island
Regatta Siding
Motor Launch Trip
Kandahar Island
Dale's Kopje
Big Tree
Landing Stage
Boat Route
Princess Christian Island
ZAMBESI RIVER
Canoe Trip
Canoe Trip
Motor Road to Livingstone
Rhodesia Railways
Memorial
Rain Forest
Victoria Falls Station
B.S.A. Police Camp
Victoria Falls Hotel
Zambesi River
1 Devil's Cataract (Leaping Water)
2 Cataract Island
3 Princess Victoria Island
4 Main Falls
5 Livingstone Island
6 Rainbow Falls
7 Danger Point
8 Boiling Pot
9 Eastern Cataract
10 Knife Edge
11 Palm Grove
12 Silent Pool.

[illegible]

leap of the Zambesi, nor is there anywhere at their crest, even in flood time, any great depth corresponding to that in the centre of the Horseshoe Fall at Niagara. But, except for shallows and broken ledges of rock which, as in the case of the Iguazu Falls, here and there cause " correderas " and miniature cascades, the river flows on calmly to the very brink of the chasm down which it is so suddenly precipitated, though of course during high water its volume and velocity are greatly increased.

While Livingstone much under-estimated the falls' dimensions, there has been a tendency in recent years quite needlessly to exaggerate them in every respect, both in brochures compiled " for the information of the tourist," and in other quarters. As a typical example, the following statement, which has been repeated *ad nauseam*, will be found in a letter from Mr. B. F. Wright, Secretary to the High Commissioner of Southern Rhodesia in London, which appeared in *The Times* of January 23rd, 1931. This letter was occasioned by a " leader " in *The Times* on the then recent rock-fall at the crest of the American Fall of Niagara, to which I have referred, and in which the writer observed that " Niagara is by no means the highest waterfall in the world, but so vast a volume of water pours over it . . . that it is by far the greatest."

Mr. Wright replied to this : " I think it is generally conceded that the Victoria Falls far surpass Niagara in size, grandeur and impressiveness. Their height (420 feet) is slightly greater than that of the cross surmounting the dome of St. Paul's Cathedral, and their width (6000 feet) is about equal to the distance between the British Museum and the Marble Arch—that is, twice the width of Niagara Falls. During the period of high water in the river it is computed that 100,000,000 gallons of water flow over the Victoria Falls a minute. The discharge at low water is 62,000,000 gallons a minute."

On my pointing out the great inaccuracy of these figures and stating the correct ones, Mr. Owen Clough, C.M.G., attempted to come to Mr. Wright's rescue in the letter to which I have already alluded in my chapter dealing with Niagara, and repeated those for the volume, which he claimed were " as ' official ' as figures can possibly be " on the grounds that they were " obtained from the Southern Rhodesian Government, through the late manager of the Rhodesian Railways (a senior R.E. officer) whose work took him frequently to the falls." He also quoted Niagara's *maximum* flow as being 95,625,000 gallons per minute (i.e. 212,908 cusecs), which would be approximately correct for its *mean* flow, but is far less than its maximum which, as we have seen, may amount to not far short of 300,000 cusecs.

As regards the above claims for the volume, which would be respectively equivalent to about 222,800 and 138,130 cusecs, I will only remark here, passing over for the moment their grotesque exaggeration, and especially of the lower figure, that to anyone at all acquainted with the high and low water conditions at the Victoria Falls, a single glance suffices to betray their absurdity, as they imply that the disparity between maximum and minimum flow is only about two-fifths, whereas the *average* difference, according to Dr. du Toit's figures, is at least 10 to 1, and, according to the more recent figures of the Survey Department of the Northern Rhodesian Government, it is 16 to 1, and, in an extreme case, may be as much as 25 to 1. I shall go fully into the question of the discharge at the falls at the close of this chapter. I need only say here that the figures which Mr. Clough claims to be "official" could clearly not have been based on actual measurements.

As regards the height of the falls, they nowhere drop 420 feet, nor even 400 feet. About the time that the railway bridge was opened across the gorge in 1905, Mr. Mansergh, the railway engineer, made the maximum drop 343 feet, and, later, the late Professor Schwarz, by measurement with a weighted line, made it 360 feet.

According, however, to the recent survey by the Northern Rhodesian Government in October, 1934, the mean height of the falls as a whole is 347 feet; the Western, or Devil's, Cataract, whose crest is 21 feet lower than that of the Rainbow Falls, being 236 feet, and the maximum drop at the latter being 354. Apart from the crest of the Western Cataract being lower, the floor of the chasm into which the great river plunges slopes sharply from west to east, the vertical descent from the foot of the Western Cataract to that of the Rainbow Falls being 97 feet. The inaccurate figure of 400 feet, or even 420 feet, so often quoted, has probably been based on the erroneous assumption that the height of the falls is the same as that of the railway bridge over the gorge some distance below them, which has long been supposed to be 400 feet. The crest of the Rainbow Falls, as a matter of fact, is 8 feet higher than the bridge, but the latter is no more than 364 feet above low-water level in reality. It is forgotten, or ignored, moreover, that there is a considerable downward slope between the actual foot of the falls and the point in the gorge where the bridge crosses it. This slope is not so very apparent to anyone looking down from the bridge, but from the edge of the Boiling Pot at the foot of the Palm Grove it is decidedly marked, as I can testify from my own observation.

The total breadth of the crest of the falls, according again to the new figures of the Survey Department of the Northern Rhodesian Government, is 1900 yards, including the various islands, and about 1500 deducting them. In their comparison, by the way, with Niagara the protagonists of "Mosi-oa-tunya," to give the falls their native name, always take very good care, and rightly so, to deduct the 1000 feet of Goat Island from the total width of the former, but they do *not* deduct the widths of any of the islands at the crest of the latter, which, in the aggregate, are considerably wider.

A glance at the air view of the falls, for which I am much indebted to the Aircraft Operating Co., which was taken at flood time, as well as a study of the plan, will easily enable the reader to comprehend their formation. Above the cataract the river widens out to over a mile, and in a stretch extending for some 4 miles above the chasm it is interspersed with more than fourteen islands of considerable size, apart from the three which are perched on the very crest of the falls and which divide them up into their various sections.

Commencing on the right, or western, bank, we have first the fall of the "Leaping Water" or "the Western Cataract," also less happily named in more recent times "The Devil's Cataract." It would seem indeed wellnigh impossible to prevent Satan from having attributed to his handiwork any great scenic marvel! It is this fall of the Leaping Water, 36 yards in width and 236 feet in depth, which carries the most concentrated volume of any part of the falls. Its crest is lower, and the river-bed has a decided slope in its direction, so that, to quote Thomas Baines, who visited the falls in July, 1862, the stream at this point "comes down like a boiling rapid over the broken rocks; the steepness of the incline, while it diminishes by a few feet the height of the actual fall, forming a channel for the reception of a greater volume of water, and allowing it to rush forward with so much violence as to break up the whole into a fleecy, snow-white, irregularly seething torrent, with its lighter particles glittering and flashing in the sunlight before it takes its final leap sheer out from the edge of the precipice into the abyss below."

To the east of the Leaping Water comes Boaruka, or Cataract, Island, between 200 and 300 yards in width, and cut through diagonally by a cleft down which a considerable body of water pours when the river is high. Baines named it "Three-Rill Island." I shall refer to it and its fissure again presently when I come to speak of the probable manner in which, according to Mr. A. J. C. Molyneux, the falls have been formed. This island, unlike Livingstone or Garden Island, where the great explorer landed, is rather risky of access, even at low water, to anyone wishing to approach it by canoe. To the east of it comes the Main Fall, which is divided by a projecting rock into two parts, one measuring 573 yards in width and the other 325 yards, the total breadth of this section of the falls being thus 898 yards, though the last edition of the *Encyclopedia Britannica*, whose account is very inaccurate, assigns to it no more than 473.

To the east of the Main Fall again comes Garden, or Livingstone, Island, from which, as we have seen, the famous missionary got his first view of the cataract. Beyond this, again going eastwards, are the so-called Rainbow Falls, but thinly water-covered and, indeed, largely bare rock when the river is low ; and these again are divided by another small island from a narrow fall on the extreme eastern bank known as the Eastern Cataract. The total width of the Rainbow Falls, including this island and the Eastern Cataract, is about 600 yards.

Thus, though the chasm into which the Zambesi here plunges is some 1900 yards in length, the actual waterway of the Victoria Falls is made up as follows :

	Yards.
The Leaping Water	36
The Main Fall	898
The Rainbow Falls and the Eastern Cataract	600
Total	1534

Niagara in its best natural state, as measured in the year 1900, and, of course, deducting Goat Island, is, or was, 1316 yards in width. The Victoria Falls do not, therefore, exceed it by more than 218 yards, and are nothing like double as is claimed by Messrs. Wright and Clough. The *Encyclopedia Britannica*, on

[illegible]

THE VICTORIA FALLS FROM THE AIR

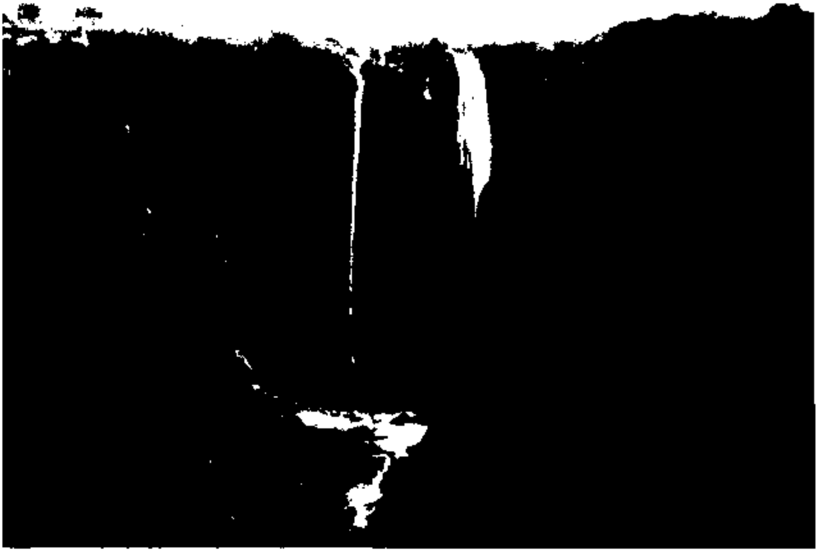
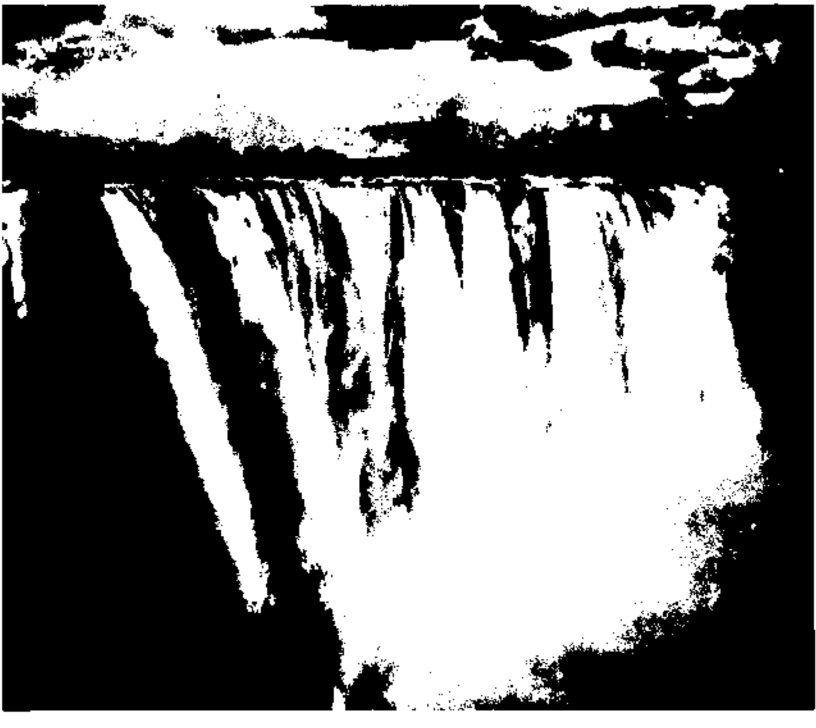


Photo by courtesy of Miss M. S. Johnston.

THE VICTORIA FALLS

(*Above*) The Rainbow Falls at low water. *Below*: The Main Falls.

Photo by courtesy of the High Commissioner for S. R.



the other hand, makes the extraordinary statement that "the chasm extending over the whole breadth of the river is about half the total width of Niagara"!

But even this small advantage in width exists only when the Zambesi is fairly high. At low water almost the whole of the 600 yards of the Rainbow Falls is bare rock, or but thinly seamed with isolated spurts and runnels, as the view here reproduced from Miss Johnston's photograph abundantly proves. Indeed, of even the Main Fall at the same period Thomas Baines remarks: "Here and there masses of rock jutted out, their tops forming islands, breaking the uniformity of the line, and their fronts interposing broad faces of dark rock, on either side of which trickled down rills too weak to jet out in curves like the others." At such times the combined width of all the channels must be far less than that of Niagara, the whole of whose breadth, in its natural state, is perennially water-covered except when partially ice-bound. As a matter of fact, in 1919 and in certain other years one could walk almost across the crest of the falls, and a friend of mine tells me that he once did so from the eastern bank to Livingstone Island practically dry-shod.

The outlet from the chasm which, to prevent confusion, may be called the gorge in contradistinction to the cañon lower down, is about 100 feet only in width, and is flanked on either side by two promontories. The one on the right, facing downstream, which is the extremity of the great spur on which the Rain Forest is situated, is known as Buffalo or Danger Point, while that on the left is called the Knife Edge. This gorge extends for 130 yards down to the Boiling Pot, a circular basin which, while not displaying any great turmoil when the river is low, becomes a veritable mäelström when the imprisoned water rushes furiously into it in flood.

The late Mr. E. F. Knight, who saw it at the latter season, describes it as "boiling, heaving, whirling, sinking into dark gulfs, leaping in pyramids, and throwing up to an immense height in spiral white columns, in smoke." The slope which I have mentioned from the foot of the falls to this point largely prevents the water piling up in the chasm itself, and thus their height is not materially decreased at high water as in the cases of the Iguazu Falls and Paulo Affonso.

It is after emerging from the Boiling Pot that the river enters the cañon where, as a glance at the plan will indicate, it turns abruptly and runs in a reverse direction in a deep trench parallel to the first chasm for a distance of 1170 yards. Then again it zig-zags backwards in a second parallel trench, and so continues back and forth for a distance reckoned to amount to about 40 miles. It will be noticed that the Palm Kloof at the back of the Knife Edge promontory is practically in a line with the first trench issuing from the Boiling Pot, and, indeed, though now dry, is a continuation of it eastwards. It is by climbing down through this Palm Kloof that access is gained to the edge of the Boiling Pot, and an excessively hot trek it is climbing back again.

In pointing out the exaggerations which are so often and unnecessarily repeated about the Victoria Falls, I trust I shall not be accused of the absurdity of attempting to belittle their magnificence. "Mosi-oa-tunya" indeed provides one of the really great spectacles of our world, and one which, except possibly at very low water, not only never disappoints the visitor but far surpasses his highest expectations. Never shall I forget my first distant view of the great white cloud soaring aloft from the hidden chasm as we drew near the falls. Beneath the full African moon, afloat in a sky of the deepest violet, the effect was as weird and unearthly as a scene in Beckford's *Vathek*; while the low thunder of the falling flood struck the ear like the heart-beats of some monstrous Titan imprisoned fathoms deep by Eblis.

Later I was to see the pale glory of the lunar rainbows spanning the misty depths at the Eastern Cataract, and recalling the Bridge of Bifrost, across which the old-time heroes of the frozen North were said to pass to their Valhalla. The more ancient name of the falls was Seongo or Chongwe, meaning "The Place of the Rainbow;" but they came later to be more commonly known as "Mosi-oa-tunya," or "Smoke does sound there," so called from those immense columns of vapour which ascend into the air to a height, at times, of 1200 feet and more above the floor of the chasm into which the river pours, and which can be discerned from many miles' distance.

The falls are not to be comprehended by people who pay them a hurried visit of a few hours only in order to be able to say they have "done" them. Indeed, even after a sojourn of several days, they remain indescribable. It is the ever-ascending spray-storm which at once provides their unique feature and yet baffles their depiction as a whole. The Aughrabies or even Niagara can be taken in at a glance; the Victoria Falls never. This constantly shifting and mysterious veil partly hides and then again reveals the purple-black cliffs of the chasm and the dazzlingly white comet-like masses of the plunging flood, investing the whole scene with an almost magical beauty. At high water it becomes so dense that, except when some fitful gust partly blows it aside, the falls are completely hidden by a curtain of surging mist. It is caused by the immense barrier of the cliff which confronts the falling waters, and which is separated from that over which they roll by no more than 80 feet at the extremities of the chasm and by about 240 at its centre. Unable to expend its force in the open, as in the case of Niagara, the spray from the falls as the latter strike the floor of the chasm is repelled by this opposing rampart, and is carried whirling upwards by the continually ascending blasts of air. To this never-ceasing spray shower, as it descends again, is also due the luxuriant foliage of the Rain Forest which crowns the cliff barrier, where a thousand little rainbows glint and glisten, and which offers a pleasing contrast to the somewhat harsh setting of the country in the neighbourhood of the falls.

And, again, it is this baffling veil of mist which invests the falls as a whole with a peculiar sense of infinity. Immense they are indeed, but the fact that one can see but sections of them at one and the same time, and can never envisage the whole at once, makes them appear even more immense than they actually are. Stand, for instance, on Danger Point, the most impressive viewpoint of all. On either side one is confronted with what the late Lord Curzon of Kedleston aptly described as " the shouting face of the cataract." One seems, indeed, almost encircled with a world of waters to which, whether to right or left as one's eye strives to pierce the mist-clouds, there appears to be no limit ; as, also, the hidden gulf beneath one's feet seems bottomless, except when a sudden gust momentarily rends the veil.

One's first impression as one stands here, drenched by the whirling and, at times, almost blinding rain-storm, is that there are, surely, no such masses of falling water anywhere in the world as these. Yet after one has visited the spot two or three times and has carefully noted the serrated edge of the cataract, when the lifting of the veil permits, it is perceived that this overwhelming effect is not caused by any such vast body of water after all.

At the time I saw them the falls were at half flood, but nowhere at the brink was there any great depth ; nothing, for instance, which could begin to compare with that in the centre of the Horseshoe Fall at Niagara, whose mass conveyed to W. D. Howells that sense of immobility and repose which, as he observed, lent its supreme beauty to the American Cataract. Here and there, as the water rushed in rather deeper measure between the rocky gaps at the edge, it preserved for a few feet downwards that deep brown, peaty hue, indicative of mass; but almost at once this colour changed into slanting wreaths and jets of snow-white foam which, converging together and striking the outward-sloping face of the cliff, rushed ever and ever downwards to the depths beneath. At very high water, of course, the crest presents one solid sheet of water, hardly a rock being visible; but the spray-clouds are then so dense that scarcely anything can be seen.

To quote again from Mr. E. F. Knight, who viewed the falls at high flood: " We saw nothing on either side of us or before us but masses of whirling vapour, and in our ears was the howling of fitful gales and the hollow roar of raging waters rising from indistinguishable depths beneath us. We might have been gazing at a primordial chaos from which, some day, after the passing of æons, a world would be created." I have already alluded to the superstitious awe with which the natives who live in their vicinity regard great cataracts. The Victoria Falls, too, were formerly no exception to this. Mr. Knight records that tufts of grass growing near the edge of the chasm had been tied at the tops by the natives into knots, giving them the appearance of nine-pins. " Each of these knotted tufts," he writes, " was a petition to the Spirit of the Falls; for the Barotse feel the awful influence of the cataract, and in recognition of and in supplication to the mystic power of the water they fashion these living prayers."

The setting of the falls is far more lovely than that of Niagara, though perahps it fails to equal in that respect the surroundings of the Iguazu Falls or those of the great Indian Cataracts with their more varied and exotic vegetation. The Palm Grove, down which a winding path leads to the edge of the Boiling Pot, is certainly more beautiful as regards its sylvan graces, or so at least it impressed me, than the Rain Forest. Here, by the way, I encountered a large cobra lying right across the path, which surveyed me with calm disdain, but presently glided off to its lair near-by.

Unlike the whirlpool below Niagara, the depth of the Boiling Pot, as far as I am aware, has never been plumbed. I have heard it rumoured that large painted logs, which have been thrown into it and have disappeared, have never been seen again by persons

Photo by Mr. Talbot

THE VICTORIA FALLS

Part of the Rainbow Falls at half flood, looking east. It is here that the maximum drop of the whole Falls occurs, namely [illegible] feet.

watching for their reappearance further down the cañon ; from which it has been contended that much of the water escapes through some hole below its surface which leads to a subterranean channel that has its exit no one knows where.

From measurements in 1905 and 1906, Mr. H. F. Varian, M.I.C.E., found the deepest sounding under the railway bridge, at a period of lowest water, to be 56 feet, which, as the high flood marks then found were 45 feet above water-level, would make the depth 101 feet during flood. He records, by the way, that not long ago a Mr. Soper and a companion actually descended to the bottom of the chasm down the cliff on the eastern face of Livingstone Island. The first part, which was very precipitous, was accomplished by means of ropes, but towards the bottom it was "moderately easy climbing." They further took a light canoe down the eastern end of the chasm "and worked their way along the bottom to a small island in the middle." Mr. Brew, the Curator on the eastern or Northern Rhodesian side, told me when I was at the falls that he intended to have steps cut down that end of the chasm, so that visitors will be able to descend in future if the state of the river permits.

It was long supposed both by Livingstone and by other visitors who succeeded him that the chasm into which the falls plunge had been caused by some violent seismic or volcanic agency, some sudden convulsion of nature : and it was, I think, Mr. A. J. C. Molyneux, F.R.G.S., who, in the *Geographical Journal* for January, 1905, first pointed out that both the formation of the chasm and of the cañon below it were due to the eroding agency of the river itself, though no doubt the time must have been immensely longer than that taken by the Niagara River to cut its way back from Lake Ontario to the point where its falls are at present situated.

It is caused, as he points out, by "the perpetual hammering action of the vast bodies of water falling into and down upon the cracks between the basalt columns, assisted by the constant vibration of the rock from the precipitated masses of water, and that by this constantly exerted force the columns are rent asunder and fall into the chasm, taking with them large and deep flakes of the precipice." This breaking down, being columnar, would account, as he explains, for the almost vertical walls of the chasm, gorge and cañon ; and the fallen blocks being constantly on the move, "cause a sub-aqueous grinding of themselves and the rocky bottom," that is to say an incessant deepening of the trenches.

Mr. Molyneux ascribes the zig-zag formation of the cañon to two causes, namely, the position of the many islands that must have studded the river in its ancient course, and "the lines of weakness in the basalt along what may be called the master joints or faults." As an illustration of the latter, he instances the fissure in Boaruka Island, to which I have already referred, and down which a considerable body of water has already begun to pour, especially when the Zambesi is high.

"It can easily be conceived," he writes, "that with the flaking of the basalt therein, in the manner described, there are probabilities of this cleft widening and receding back in a direction that is diagonally across the present course of the river, and peculiarly enough, almost parallel to the first arm below the gorge. The erosion of this crevice must be slow at first, but as it recedes back the amount of water intercepted and deviated from the main falls must increase in rapid ratio. It would thus appropriate millions of tons of water that would otherwise proceed to fall over the precipice, of which portions would thus become dry and consequently free from the beating-down action of the stream. A new direction for a strong current is thus set up, the chasm yearly becomes of greater magnitude, and at last attains the grandeur of the main fall."

The falls have long, of course, been easily accessible by rail. One can leave Cape Town at 11.30 on a Monday morning and traverse the 1640 miles to them by 9.45 on the following Wednesday evening. From Beira the route is considerably shorter; and to-day they can also be approached from Lobito Bay, though the latter trip is close on 2000 miles. Not the least of the surprises that awaits one here at the "back of beyond," so to speak, is the admirable hotel on the Southern Rhodesian side, which I thought far superior to any other I had met with in all South Africa. Apart from this hotel with its charming surroundings, however, far more money is to be spent in the near future in improvements on the Northern Rhodesian bank of the river.

It was stated while I was at the falls that no less than £50,000 would here be devoted to tourist development. This was to include £15,000 for the Livingstone Memorial Museum, £10,000 for a new hotel on that side, £10,000 for a new road along the Zambesi to Katombora, and a further £8000 for other tarred roads to various points on the winding cañon. Besides the above, it is proposed to establish a game park at an initial outlay of £3000 with £1400 per annum for the maintenance of the same;

a botanical garden and a swimming pool are each to cost about £2000 ; while a further £1000 will be devoted to furnished huts on the northern camping ground and the laying on to them of water and electric light, apart from other sums for publicity, etc.

I have left to the last the discharge of the Zambesi at the falls at the river's various stages. The figures which I have adopted throughout this book in comparing the volume of the Victoria with that of other great falls, and to which, for reasons presently to be stated, I still adhere, are to be found in the exhaustive report of Dr. A. L. du Toit who, together with the engineer, Mr. C. Sholto Douglas, and the assistant engineers, Messrs. S. H. Noaks and L. L. R. Buckland, took careful measurements of the flow of the river at Kamajomas, some 14 miles above the falls, in 1925, the three latter gentlemen being chiefly responsible for the actual gaugings and calculations. This report is entitled *The Report of the Kalahari Reconnaissance of* 1925, and was issued by the Department of Irrigation of the Union of South Africa and published by the Government Printing and Stationery Office at Pretoria in 1926. The object of this reconnaissance was to investigate certain proposals of the late Professor Schwarz for reclaiming part of the Kalahari Desert, and among much other survey work that was accomplished there was included the measurement of the discharge of the Zambesi above the falls.

The figures given cover the period from 1908 to 1925 inclusive, and it may be noted here that those for the low-water volume agree fairly well with previous measurements both by Professor Schwarz and by Mr. Varian. The former, for example, at a time when the river was approaching the low stage, found the flow to be 11,749 cusecs ; while Mr. Varian, in September, 1906, found it to be 9000, sinking to 7500 in October of the same year. He further states that in July, 1905, at Secuti's Drift, 5 miles above the falls, the total discharge was 13,500.

Dr. du Toit's figures are as follows :

	Cusecs.
Minimum flow	8000 to 10,000
Mean annual flow	38,430
Average flood flow	82,000

That is to say, that the mean annual flow is well under one-fifth of that of Niagara, while the average flood flow is little more than two-fifths of it.

The flood flow reaches its maximum with remarkable regularity about the end of April or the beginning of May. It varies immensely, but the following are the figures given by Dr. du Toit for the eighteen years from 1908 to 1925 inclusive :

Flood Volumes

Year.	*Cusecs.*	*Year.*	*Cusecs.*
1908	65,000	1917	106,000
1909	121,000	1918	99,000
1910	105,000	1919	52,000
1911	73,000	1920	90,000
1912	88,000	1921	92,000
1913	77,000	1922	52,000
1914	73,000	1923	97,000
1915	45,000	1924	55,000
1916	54,000	1925	140,000

It will be observed that during the above eighteen years the flood flow reached or exceeded the 100,000 cusecs mark on four occasions only, and that, except for the unusually high figure of 1925, it fell very far short in every year of the 138,130 cusecs which Messrs. Wright and Clough assert to be the *low-water* volume.[1]

At the time of the big 1925 flood the height reached by the river at the Livingstone Pumping Station was 8 feet 8 inches. Dr. du Toit goes on to state that " in April, 1926, the river in amazing fashion overtopped the 1925 record by no less than 1·6 foot, which would imply a discharge of not less than 180,000 cubic feet per second." That, be it noted, is to say that the further rise of approximately 19 inches was productive of an increased flow of 40,000 cusecs.

Before passing on to the new measurements made by the Survey Department of the Northern Rhodesian Government, which give results so enormously different from those of Dr. du Toit that there is no possible means of reconciling them, it may be pointed out that the latter and his assistants were very careful to select a site for their discharge station that was likely to preclude errors as far as possible. As is well laid down in an engineering textbook by Mr. David Clark : " To avoid *abnormal* results, the site at which the measurement is to be made—called the discharge station—must be selected so that the stream lines are as regular as possible. The stream should be nearly straight for some distance on either side of the station, and the channel should be free from obstructions and have its bed fairly uniform in slope and character."

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[1] The Americans err in the other direction. Professor R. M. Field in *The Principles of Historical Geology from the Regional Point of View* actually quotes the volumes of the Victoria and Iguazu Falls as equivalent to no more than 7530 and 5013 cusecs respectively ! I note that the same absurd figures are given in a booklet issued by certain Niagara Power Companies, entitled : *The Lengthening of Niagara Falls.*

In the above quotation I have italicised the word " abnormal."

In Appendix I to the *Report of the Kalahari Reconnaissance* Mr. C. Sholto Douglas writes :

" An examination of the river section at the Railway Gauge Post, situated three-quarters of a mile above the falls, showed this site to be inconvenient for current-meter observations, as the river is cut up into several channels by islands and the stream is rapid and turbulent. The section of the river at the pumping station, about 2 miles farther upstream, was also viewed unfavourably on account of the presence of a large island. It was therefore decided to select a more suitable spot for our measurement higher upstream. At Kamajomas, some 14 miles above the falls, it was found that the river is confined to one channel at all seasons, and the flow appeared to be fairly uniform. Gaugings were therefore made at this site," etc.

In contradistinction to this, the measurements made by the Survey Department of the Northern Rhodesian Government appear to have been carried out at some point not far above the falls across a very broken and irregular section of the river, where errors might reasonably be expected to be far more liable to occur. They cover the period 1926 to 1934 inclusive, and the results are so immensely higher than those given by Dr. du Toit that at first glance one might suppose that by some freak of nature the Zambesi had suddenly and mysteriously trebled and quadrupled its volume. That, of course, is not the case, as the readings on the gauge post, except for the record rise of 1934, average much the same as in previous years.

Mr. W. G. Fairweather, the Director of Surveys, who has kindly let me see these figures through Mr. Brew, the Curator of the Northern Rhodesian side of the falls, points out, it is true, that Dr. du Toit's figures, being the results of measurements taken some 14 miles upstream, did not include the Sindi and Maramba Rivers, whose confluences with the Zambesi are well below that point. But it is absurd to suppose that the combined contribution of both these quite minor streams could possibly account for more than a mere fraction of the disparity involved.

Professor Schwarz, indeed, emphasises the fact that the Maramba is not a river at all, but merely a backwater. In quoting the figure of 11,749 cusecs mentioned above, he says: "... there are no affluents to the river below this point, the Maramba being merely a backwater."

Be that as it may, the figures given by Mr. Fairweather are as follows:

	Cusecs.
Lowest minimum discharge (October, 1924) .	17,500
Mean minimum discharge	19,500
Mean annual discharge	125,000
Mean maximum discharge . . .	317,000
Highest recorded maximum discharge . .	440,000

As will be seen at a glance, the difference is not one of merely a few thousand cusecs. The mean annual discharge is approximately three and a quarter times as much as that given by Dr. du Toit, while the average flood flow is nearly four times as much. Again the maximum record volume of 440,000 cusecs is enormously in excess of the highest flood figure mentioned in the *Report of the Kalahari Reconnaissance.*

The river at this time, namely, in April, 1934, made the record rise of 11·34 feet, which exceeds the rise of 1926, when Dr. du Toit assessed the discharge at 180,000 cusecs, by approximately 15 inches. We have seen that the increase of 19 inches as between the flood of 1925 and 1926 was productive, according to Dr. du Toit's calculations, of a further 40,000 cusecs. On that basis, not allowing, however, for the increased velocity, the further 15-inch rise of 1934 would not produce more than approximately a further 30,000 cusecs; which would make the total discharge at the falls at that time about 210,000 cusecs, or slightly less by about 2000 cusecs than the mean flow of Niagara.[1]

It is quite impossible to reconcile these different figures, or to avoid the conclusion that there must be a huge miscalculation somewhere or other. Personally, I have no hesitation in adhering to Dr. du Toit's figures for the following reasons:

Firstly, the discharge station he selected was far more likely to give correct results than that chosen by the Survey Department of the Northern Rhodesian Government.

Secondly, his figures for the low volumes are fairly well in accordance with those both of Professor Schwarz and of Mr. Varian.

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[1] I have since heard from Dr. du Toit that, allowing for the much greater surface and subsurface velocities, Mr. C. Sholto Douglas would estimate the *approximate* discharge of the 11·45 foot rise to be 250,000 cusecs.

And, thirdly, it seems to me most unlikely that the comparatively small rainfall of the basin of the Upper Zambesi above the falls, which is generally reckoned to be between 30 and 40 inches, and is probably nearer 30, could be productive of such high volumes as are given by the Survey Department. The Iguazu, for instance, has certainly more than double this rainfall, namely, 157 inches at its source and 79 throughout its basin, though it is true that that basin occupies a less extent. Its length up to the falls, moreover, is greater. Yet, as we have seen, the mean volume has been reckoned to be 61,660 cusecs. How, then, can that of the Zambesi be anything like 125,000? To me it seems that Dr. du Toit's figure of 38,430 is by far the more probable.

The gauging of the correct discharge at the falls is, of course, of very great importance in view of their future development as a source of power. Years ago the ridiculous statement was made that they could supply 35,000,000 h.p. The amount to-day is generally estimated as being from 250,000 to 600,000 according to the season. The *Report of the Kalahari Reconnaissance* observes in regard to this:

"The agreement between the African Concessions Syndicate and the Victoria Falls Power Company gives the latter the full right until 1981 to develop up to 250,000 electrical h.p. The agreement between the Chartered Company and the African Concessions Syndicate gives the latter the additional right to all above the 250,000 h.p., granted to the Victoria Falls Power Company, subject to the maintenance of the natural beauty and characteristics of the falls, and, furthermore, the permission to store water within a distance of 30 miles of the falls. As there is no suitable site for this, chiefly owing to the considerable fall in the river and also the general narrowness of the valley, such a concession has no real value; moreover it is difficult to see how the falls could be maintained as specified were even the Victoria Falls Power Company to exercise its unqualified rights. The maximum steady output of power at the falls would be dependent upon two factors: (1) the minimum flow of the river, and (2) the height to which the flood will rise in the gorge below the bridge during the early autumn. The control of the Zambesi at Katombora would by reducing (2), augment the available head from 315 feet to 355 feet approximately, and so actually *increase* the power obtainable under minimum flow. Even with this greater head somewhere about 8000 cusecs would be needed for the production of 250,000 h.p., which is about equal to the lowest recorded discharge of the river. . . . It is apparent that were the Victoria Falls Power Company to take *all the power to which it is legally entitled*, the waterfall would be reduced to an absolute trickle in the spring[1] during most years."

The report further calculates that it would take a flow of not less than 20,000 cusecs to display the falls to their fullest advantage; and it must be remembered that the season of comparatively low water, when the flow would be much less than the mean of 38,430, usually lasts for nearly five months in any ordinary year.

The so-called Victoria Falls Power Company has not, to date, harnessed a single gallon of the water. In a recent speech to the Press Delegates, however (February, 1935), Sir Hubert Young, the Governor of Northern Rhodesia, announced the probability of the completion of a hydro-electric scheme within the next couple of years. I have seen the point whence it is proposed to divert the water a short distance above the Eastern Cataract, and it is said that the power house will be placed at the Silent Pool at the eastern extremity of the second trench after the river leaves the railway bridge. Sir Hubert stressed that every care would be taken to preserve the beauty of the falls and there is no doubt at all that he meant it. But with so many deplorable examples elsewhere, when once the thin end of the wedge has been inserted, any scheme for harnessing this supreme natural wonder cannot be too carefully scrutinised.

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[1] The terms autumn and spring refer, of course, to those seasons as understood in Rhodesia.

CHAPTER XIII

THE AFRICAN GIANTS : THE RUA CANA FALLS ON THE KUNENE RIVER

THE Rua Cana Falls on the Kunene River, which forms the northern boundary of what is now the South-west African Protectorate, in the same way that the Orange River limits it on the south, are very little known even to-day. Our chief authority on them, as far as any account in English is concerned, is Mr. Francis E. Kanthack, C.M.G., who, during the summer of 1920, was at the head of a British Commission which met a Portuguese one at these falls in order to negotiate a settlement of a long-standing frontier dispute between Portugal and Germany, and to delimit the boundary. Mr. Kanthack's account appeared in *The Geographical Journal* for May, 1921, from which the following particulars are mainly taken. I am also indebted to him for his kind permission to let me reproduce the views here shown of the western end of the falls.

There had previously been some explorations in the region under review by Dr. George Hartmann in 1900 and 1901, who mentions three separate cataracts, the third of which, and presumably the one furthest down the river, he characterised as an imposing fall, never before described, of over 300 feet in height ; and he expressed the opinion that in time of flood it could " hardly be inferior in grandeur to Niagara or the Victoria Falls." And again in 1912 there was an expedition by Count Jacques de Rohan-Chabot, some details of which were recorded by Captain Grimaud in *La Géographie* for January, 1913. The latter speaks of an upper fall which was then, in the dry season, no more than about 20 yards in width with a drop of 195 feet, and as well, of a lower one of which he does not clearly state the height, but which he called Quedas Montenegro.

The Kunene River rises in the highlands of Angola and has a total course of about 750 miles. It first flows almost due south for some 450 miles, then turns south-west for 100 miles to a point called Erickson's Drift, whence, again, its course is, generally speaking, westerly to the South Atlantic. It is at Erickson's Drift, so named after a well-known trader who is said to have crossed the river with his waggons into Angola at that spot, that the Kunene reaches the edge of the great interior African plateau, and about 5 miles below that point, at the Kavale Rapids, that it begins to descend over 3000 feet to the coast.

The flow of the Kunene is subject to great variations. Measurements given by Mr. Kanthack show that the volume at the Kavale

Rapids, 25 miles above Rua Cana Falls, may sink to no more than 500 cusecs in September, but may attain to as much as 40,000 cusecs, or rather more than the mean annual volume of the Victoria Falls, in March. During high water, therefore, seeing that the falls are 406 feet in total height and have a crest line, at that time fully covered, of over 760 yards, they are certainly entitled to be included among our African "Giants." Indeed, apart from the peak figure for March, from December to May inclusive, the flow will not usually sink below 10,000 cusecs and may be double and treble that amount in February and April.

Though well-known, of course, to the Portuguese for many years past, Mr. Kanthack states that all former accounts of the river between Erickson's Drift and the falls, "both official and otherwise," are erroneous and wholly misleading. Above the Kavale Rapids, the crest of which is 3251 feet above the sea, the river's valley is but little below the level of the surrounding country. The main channel of the stream is from 100 to 200 yards in width, and both it and the subsidiary ones are largely bordered with a dense growth of reeds.

At the Kavale Rapids, which are sometimes called "the upper or small cataract" to distinguish them from "the large cataract," or Rua Cana Falls, there is a total descent of 38 feet in two parts. The first is a rapid followed by a small fall, which drops, in all, from 15 to 20 feet into a straight, narrow and shallow gorge; while the second is a drop into a deeper gorge of about 20 feet. These Kavale Rapids extend for a mile. Below them again, the valley gets deeper and the gradient of the river increases till the Chimbombe Rapids are reached, where, over a distance of several miles, the river, now divided up into numerous channels worn into granite and other igneous rocks, drops, in all, a further 68 feet. These are followed by a further succession of rapids and pools till the Rua Cana Falls are reached, to the crest of which from the commencement of the Kavale Rapids the total descent is 485 feet in a distance of about 24 miles.

"At the level of the crest of the falls," writes Mr. Kanthack, "the plateau on the Angola side of the river consists of granites, schists and quartzites. Approximately along lat. 17° 25′ S. is the junction of these ancient rocks with the felspathic grits, sandstones, conglomerates and tufas of the Otavi series. It is evident that the Kunene has cut its way along this junction for many miles west of the Rua Cana Falls. This big drop is caused by the hard nature of the granites and schists."

The Kunene approaches its great leap from the north, and for about 3 miles of its course above the falls it is over a mile in width, but divided up, like the Orange, into numerous channels between swamps of reeds and rocky islands. Some 700 or 800 yards above the falls the valley narrows to 1000 feet, hemmed in on either side by slopes of granite, and the central channel of the river runs through a straight granite bed with a breadth, at low water, of no more than from 50 to 100 feet. Then again the valley widens out right up to the crest of the cataract, forming " a kind of delta which is a wilderness of granite intersected by a network of channels."

The crest itself is irregular. The western part of it runs due east and west, while the eastern half slopes back, running from north-east to south-west. The principal channel of the river, which always contains the most water, is on the right or western bank, while there is a similar but smaller channel on the eastern side. Thus at low water, the cataract usually consists of two main falls at the western and eastern ends respectively, while all the central part of the crest, except for a few isolated runnels, is practically bare rock. It has thus considerable resemblance at that time to the Rainbow section of the Victoria Falls when the Zambesi is low. But at high water, as I have already mentioned, the whole of the 760-yards crest is water-covered, presenting an imposing and magnificent fall.

Below the falls, the gorges formed by the two side falls converge towards each other and meet beneath the great rock wall at about its centre. The ravine then zigzags between cliffs of over 400 feet in height for a distance of a little over a mile, where it forms a large pool, and then exits out into a broad valley below. The figure of 406 feet given by Mr. Kanthack for the height of the falls is from the crest to the pool below the gorge. The main and western fall is higher than the eastern one. From the western side, also, subsidiary channels conduct part of the river's flow around that end of the main fall to form additional cataracts into the gorge some distance lower down.

Mr. Kanthack tells us that the name Rua Cana is probably a Portuguese corruption of an old native name. Very little appears to be known of the course of the Kunene below Rua Cana Falls, but it is said that the valley is cut deep into the mountains and is extremely wild and rough. It was also rumoured formerly that at the lower falls, or Quedas Montenegro, the river made an even greater drop than at Rua Cana.

Captain Grimaud, of the Rohan-Charbot expedition, stated that the Quedas Montenegro occurred at a bend of the river and in a part of it sown with numerous islets, and that they could be approached only from what was then the German, i.e., the southern, bank; and further that they presented an aspect entirely different from the falls of Rua Cana. He did not, however, give any figure for their height. One gathered that the cataract was situated in a narrow gorge and was followed by a series of cascades down to the point where the Kunene issues from the mountains out through the sandy belt known as the Namib or Coastal Desert, which stretches almost from the southern extremity of the Continent up to and beyond its mouth, the belt in question varying from 30 to 80 miles in width.

Mr. Kanthack, however, tells me that there are no big falls between Rua Cana and the sea, and that the so-called Quedas Montenegro, which had been seen by Major Manning, one of the members of Mr. Kanthack's Boundary Commission, consists merely of a series of rapids. This effectually disposes of the rumour that there is any other large fall besides the Rua Cana. It is interesting to note that throughout the whole length of the Coastal Desert above referred to, the Orange and the Kunene are the only streams entering the Atlantic whose flows are not intermittent.

CHAPTER XIV

THE FALLS ON THE VICTORIA AND THE BLUE NILE

THE next important African waterfalls we shall discuss are those on the ancient "River of Egypt," the immemorial Nile, which, after the Missouri-Mississippi and the Amazon, can claim to be the longest, as it was for centuries the most mysterious, of the great rivers of the world. These are respectively the Murchison Falls on the Victoria Nile, and the Tisisat Falls on the Blue Nile, or, as it is more usually called in its upper reaches where the falls occur, the Abbai.

It was on March 16th, 1864, that the Lake of Albert Nyanza was first seen by Sir (then Mr.) Samuel Baker and his wife, and a little later that same year that they proceeded to trace the course of the Victoria Nile upwards from the point where it enters that lake, and so came upon the Murchison Falls. "This," wrote the explorer, "was the greatest waterfall of the Nile, and in honour of the distinguished President of the Royal Geographical Society, I named it the Murchison Falls, as the most important object throughout the entire course of the river."

Already, on July 28th, 1862, Speke had discovered the Ripon Falls where the Nile leaves the northern edge of Lake Victoria Nyanza, of which it is the only outlet, 218 miles above those of Murchison. At the Ripon Falls, so-called after Earl de Grey and Ripon, the then President of the Royal Geographical Society, the river has a breadth of from 150 to 170 yards. It pours through gaps in a reef of rocks which here crosses its bed diagonally, dropping some 16 feet and with a mean annual volume of 20,306 cusecs, rising to a maximum of 23,014. From this point to its Rosetta mouth, the Nile is 3473 miles in length; or, if one reckons it from the source of its longest headstream, the Kagera, the distance amounts to 4037 miles. A bridge now crosses the river at Ripon Falls, below which the banks of the Nile rise steeply to a height of 150 feet.

For a stretch of some 35 miles after leaving the lake, rocks and rapids render the stream unnavigable. It then enters the low-lying tract occupied by the lakes of Choga and Kwania, through which it flows; but after leaving the latter it develops into a deep and navigable stream for a distance of some 120 miles, and with an average breadth of from 280 to nearly 400 yards. Indeed, at Mruli it attains a width of over 750 yards. After reaching Foweira the river turns sharply westwards, surges down the

Karuma Rapids, and then flows over a succession of further rapids till it comes to the Murchison Falls.

The latter, by the way, must not be confused with the Murchison Cataracts on the Shire River south of Lake Nyasa, where the Shire descends about 1250 feet over a distance of 45 miles.

Sir Samuel Baker has described his discovery in his book, *The Albert N'Yanza*, published in 1866.

" From the time we had entered the river," he wrote, " it had been confined by heights somewhat precipitous on either side, rising to about 180 feet. At this point the cliffs were still higher, and exceedingly abrupt. From the roar of the water, I was sure that the fall would be in sight if we turned the corner at the bend of the river ; accordingly I asked the boatmen to row as far as they could : to this they at first objected, as they wished to stop at the deserted fishing village, which they explained was to be the limit of the journey, further progress being impossible. However, I explained that I merely wished to see the fall, and they rowed immediately up the stream, which was now strong against us. Upon rounding the corner, a magnificent sight suddenly burst upon us. On either side the river were beautifully wooded cliffs rising abruptly to a height of about 300 feet ; rocks were jutting out from the intensely green foliage ; and rushing through a gap that cleft the rock exactly before us, the river, contracted from a grand stream, was pent up in a narrow gorge of scarcely fifty yards in width ; roaring furiously through the rock-bound pass, it plunged in one leap of about 120 feet[1] perpendicular into a dark abyss below. The fall of water was snow-white, which had a superb effect as it contrasted with the dark cliffs that walled the river, while the graceful palms of the tropics and wild plantains perfected the beauty of the view."

Sir Samuel Baker got to within 300 yards of the base of the fall, but could not proceed nearer on account of the powerful currents and the whirlpools. Below the falls immense numbers of crocodiles lay on the banks " like logs of timber close together," as, indeed, they do to-day. The famous explorer describes how he shot one of these, and how the report of the rifle so alarmed the native boatmen that they dropped into the body of the canoe, afraid to attend further to the boat. One of them in his fright lost his paddle ; and just as the canoe was, in consequence, swung around by an eddy into a thick bank of reeds, they were

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[1] Mr. H. F. Varian, M.I.C.E., writing in the *Geographical Journal* for July, 1934, says the total drop is " about 400 feet in two sharp steps."

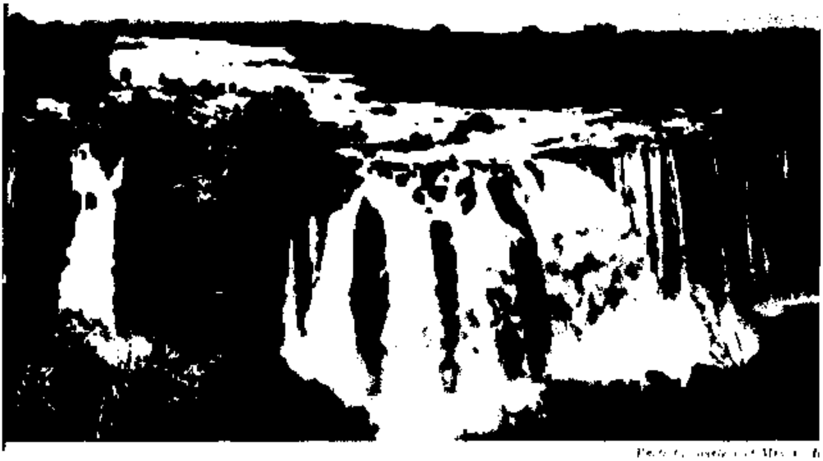

Photo by courtesy of Mrs. [illegible]

Above: THE TISISAT FALLS ON THE ABBAI

Below: THE MURCHISON FALLS

Photo by courtesy of Mrs. [illegible]

charged by an indignant hippopotamus, who half lifted the boat out of the water, but fortunately no further harm resulted.

The Murchison Falls have probably been seen—at second-hand, so to speak—by a greater number of the untravelled public than any other falls of the world which are situated in comparatively remote regions, as they formed the setting to some of the scenes in the well-known film of *Trader Horn*. The views there shown admirably depicted the narrow cleft through which the torrent pours, as well as the foaming and tossing aspect of the river immediately above it. The accompanying photographs, for both of which I am indebted to Miss E. L. Tottenham, author of *Highnesses of Hindostan*, show this cleft looking upstream and downstream respectively. Mr. C. S. Betton, who wrote an account of a visit to the falls in *Nature* for June 19th, 1902, speaks of the torrent as slithering in a solid mass through this extraordinary cleft, and mentions that an officer in the Uganda Rifles, who measured it at its narrowest part, found it to be no more than 18 feet in width; but its depth is not known.

Measurements of the volume taken about 10 miles below the falls on March 20th, 1903, at the end of the dry season when the river was at its mimimum flow, showed 20,377 cusecs; but there is, no doubt, a very considerable increase—probably half as much again—in the rainy season.

It would seem from the different descriptions of the Murchison Falls, such as those of Mr. Betton, Mr. Weldon and others, that their aspect has altered considerably, and that the greater part of the river formerly entered the basin below the present cataract, not by the cleft above described as now, but by a separate fall which plunged into it from another channel on the north.

Mr. Weldon, for instance, described a river over 20 yards wide coming down from the north and joining up with a branch of the Nile which separated out from the latter a little above the existing cataract; and he stated that the two rushing together formed another fall entirely of considerable size to the north of the existing one. This fall fell into a large rock basin and then joined the main river below.

Mr. E. B. Worthington, commenting on the above in the *Geographical Journal* for August, 1929, states that since Mr. Weldon's visit this stream of 20 yards in width, as well as the separate and northerly branch of the river which the latter described, is now a dry watercourse, and consequently that the fall mentioned by Mr. Weldon no longer exists; and further, that the rock basin into which it poured is now partly filled with stagnant water. He concludes that the above-mentioned northerly watercourse formerly took most or nearly all of the river, and that it has only recently broken through the narrow cleft in the rock, thus forming the present cataract. This conclusion appears to be borne out by Mr. Betton, who, on climbing to the top of the fall, found a rocky plateau indented with potholes, one of which was 15 feet in diameter by 10 in depth, which marked the level of the former bed of the Nile where it once swirled around a mass of gneiss in the centre. This, as he explains, became gradually worn away on the southern side, exposing a softer vein through which the river eventually cut its way, thus forming the cleft through which it now pours.

Above the main cataract he found that the Nile rushed over a succession of low falls, gaining increasing velocity as it narrowed on approaching the cleft, down which it surged in a seething mass for a distance of 150 feet. He also describes a curious roar caused by the tumbling water, and accounts for it by the intermittent breaking of great waves in the pool at the foot of the falls. Below this pool the river flows for some miles through a gorge, which presently opens out into the swampy, low-lying land to the north-east of Lake Albert into which it debouches.

The falls of Tisisat in Abyssinia occur on the Blue Nile or Abbai about 20 miles below the point where the river leaves Lake Tana, which is situated 6000 feet above sea-level and has an area of over 1181 square miles, being about 40 miles wide by 50 in length. From its source at Gish Abbai to where it enters the lake, the river has a course of some 60 miles.

It is recorded by Father Jerome Lobo that the first European to see the Abbai's source was one Father Peter Payz, a Portugese Jesuit, in 1613, a fact which in later years caused considerable chagrin to the celebrated traveller James Bruce, who was anxious to claim the honour of having himself discovered it in 1770. It is the latter who has given us what is perhaps the earliest account of the falls, which he was at great pains to visit, frequently expressing his impatience at the delays he had to put up with in reaching them.

"The cataract itself," he writes, "is the most magnificent sight that ever I beheld. The height has been rather exaggerated. The missionaries say the fall is about 16 ells, or 50 feet. The measuring is, indeed, very difficult, but, by the position of long sticks, and poles of different lengths, at different heights of the rock from the water's edge, I may venture to say that it is nearer 40 feet than any other measure. The river had been considerably increased by rains, and fell in one sheet of water, without any interval, above half an English mile in breadth, with a force and noise that was truly terrible, and which stunned and made me, for a time, perfectly dizzy. A thick fume, or haze, covered the fall all round, and hung over the course of the stream both above and below, marking its track, though the water was not seen. The river, though swelled with rain, preserved its natural clearness, and fell, as far as I could discern, into a deep pool, or basin, in the solid rock, which was full, and in twenty different eddies to the very foot of the precipice, the stream, when it fell, seeming part of it to run back with great fury upon the rock, as well as forward in the line of its course, raising a wave, or violent ebullition, by chafing against each other."—(*Travels to discover the Source of the Nile*, 1790.)

It is curious to what an extent Bruce seems to have underestimated the height of the falls, unless the explanation may be that, as the river appears to have been very high at the time, the basin into which it plunged may have been filled up to a much higher level than at ordinary times, thus decreasing the drop. Mr. C. Dupuis, of the Egyptian Irrigation Service, in his *Report upon Lake Tsana and the Rivers of the Eastern Sudan* (1904), who appears to have seen the falls when the stream was low, says the latter descend " fully 150 feet in a single leap " ; while Major R. E. Cheeseman, in the *Geographical Journal* for April, 1928, describes the cataract as " a magnificent waterfall where the Abbai hurls itself over a precipice some 200 feet high."

If my supposition is correct, it may also account for Bruce's wrathful incredulity at Jerome Lobo's claim to have climbed down at one point and to have sat himself behind the fall.

" Jerome Lobo pretends," he continues, " that he has sat under the curve, or arch, made by the projectile force of the water rushing over the precipice. He says he sat calmly at the foot of it, and looking through the curve of the stream, as it was falling, saw a number of rainbows of inconceivable beauty in this extraordinary prism. This, however, I, without hesitation, aver to be a downright falsehood. A deep pool of water, as I mentioned, reaches to the very foot of the rock, and is in perpetual agitation. Now, allowing that there was a seat, or bench, which there is not, in the middle of the pool, I do believe it absolutely impossible, by any exertion of human strength, to have arrived at it. Although a very robust man, in the prime and vigour of life, and a hardy, practised, indefatigable swimmer, I am perfectly confident I could not have got to that seat from the shore through the quietest part of that basin. And, supposing the friar placed in his imaginary seat under the curve of that immense arch of water, he must have had a portion of firmness, more than falls to the share of ordinary men, and which is not likely to be acquired in a monastic life, to philosophise upon optics in such a situation, where everything would seem to his dazzled eyes to be in motion, and the stream, in a noise like the loudest thunder, to make the solid rock (at least as to sense), shake to its very foundation, and threaten to tear every nerve to pieces, and to deprive one of other senses besides that of hearing. It was a most magnificent sight, that ages, added to the greatest length of human life, would not deface or eradicate from my memory ; it struck me with a kind of stupor, and a total oblivion of where I was, and of every other sublunary concern. It was one of the most magnificent, stupendous sights in the creation, though degraded and vilified by the lies of a grovelling, fanatic peasant."

Bruce's extravagant eulogy of the falls makes one wonder how he would have found words to describe Mosi-oa-tunya, the Iguazu marvel, or Paulo Affonso, in their incomparably greater magnificence, to name but a few of the giants we have discussed ! I venture to think that the castigated Jerome Lobo may not have been such a liar after all if he performed the feat in question at low water. Major Cheeseman, indeed, writes : "During the May visit" (when the stream would be low), "it was possible to climb down the steep face of the ravine on the right bank of the falls, and, by passing behind the water of the side fall, gain the shelf in the middle of the main fall." So the friar would appear to be vindicated after all.

As a matter of fact, according to the *Report of the Mission to Lake Tana* by Messrs. G. W. Grabham, F.R.S.E., and R. P. Black (1925), the discharge at the outlet of Lake Tana varies in normal years from almost nothing to a maximum of about 12,358 cusecs ; and according to Mr. C. Dupuis the *mean* discharge at the falls is 3,500,000 cubic metres per day, or no more than a little over 1400 cusecs. Mr. A. d'Abbadie, on the other hand, estimates the discharge even in the dry season to be as much as 4767 cusecs and over. Be that as it may, the variation in flow is great, and the aspect of the falls and of the gorge below them consequently varies immensely at different seasons.

Major Cheeseman gives the width of the river above the falls as 400 yards, and describes it as being of considerable depth but with a slow current, due to the fact that the ridge of rock forming the falls also dams back the water so as to form a lagoon in the river-bed. He explains, by the way, that the name Tisisat is derived from the Amharic word, *tis*, meaning smoke, and *isat*, meaning fire, owing to the clouds of fine spray that are wafted away from the base of the surrounding hills.

The gorge below the falls is crossed at a little distance down by a curious bridge known as the bridge of Agam Deldi, or the Alata bridge, by which latter name the falls are also known. It was built by the Portuguese of basalt, the arches being filled in with small dressed sandstone blocks. It consists of one main arch, of no more than a 25-foot span, which crosses the stream, and seven or eight other arches on the western side. The gorge is here more than 60 feet deep, but often narrows to no more than 12 to 15 feet and even less.

Major Cheeseman, indeed, states that at one point it is only 7 feet across, and he relates that an Abyssinian warrior is recorded to have once jumped across it from rock to rock during a local war, and, having killed his enemy on the opposite side, to have jumped back again; for which feat he was created a Nagadras on the spot by the Emperor Menelek. Down this gorge the torrent roars foaming over a succession of cascades, and during the rainy season the whole ravine is filled up with water, the right bank, which is lower, being even overflowed to a considerable extent. Captain H. G. Lyons in *The Physiography of the River Nile and its Basin* (1906) mentions another broken bridge some thirty odd miles below that of Agam Deldi, known as the Andabit bridge.

Lower down, the gorge, according to Major Cheeseman, becomes "a huge rugged valley with mountains each side towering some 6000 feet above the water-level, and from 6 to 10 miles from side to side," and he goes on to say that in the bottom of this valley the river has in places eroded a narrow ravine with cliffs often 400 feet high, the water being frequently invisible till one stands on the cliff edge immediately over the top of it. He further observes that tributaries of the Abbai are here hurled headlong over a thousand-foot precipice, often with a sheer drop of hundreds of feet, which would entitle these little known and, apparently, unnamed falls to be included among the very high falls of the world.

I am indebted to the kindness of Mrs. H. C. Bentinck for the accompanying view of Tisisat. The Abbai, or Blue Nile, joins the White Nile at Khartoum about 994 miles below Lake Tana and its discharge at that point, according to Captain Lyons, varies from about 4238 cusecs in April to the impressive amount of 197,056 in August and September.

CHAPTER XV

SOME FURTHER NOTABLE WATERFALLS OF AFRICA

BEFORE leaving Abyssinia there ought to be mentioned two fine falls on the Webi River which rises in the southern mountains of the country, and after flowing through the highlands of the Galla region and entering Somaliland, loses itself in a great swamp before joining the Juba River. These falls occur near Shedala above the confluence of the River Hako, and were, I think, first described by the late Duke of Abruzzi in his book *La Esplorazione dello Uabi-uebi Scebeli dalle sue sorgenti nella Etiopa Meridionale alla Somalia Italina*, in which he recounted the results of his expedition of 1928–29.

At the first fall the stream plunges down between vertical walls of rock from a height of over 459 feet into a deep basin throwing up clouds of spray shot through with iridescent rainbows. In addition to the main fall, a side cascade issues from a deep lateral cleft in the rock, plunging down rather at right angles to the other. The colour of the cliffs, which are a pale primrose, adds to the picturesqueness of the scene. The second fall of some 229 feet is scarcely less imposing than the first, and also plunges into a very deep basin in the rocks. Both are described by the explorer as being truly magnificent falls. After the Hako joins it, the Webi flows on in a tremendous cañon more than 1000 feet in depth.

Proceeding southwards down the eastern side of Africa, the falls on the Tana River may be noted which flows into the sea at Formosa Bay, a little south of Lamu. Unfortunately I have not been able to find any detailed account of these falls. They are alluded to by Dr. Peters in his book *Au secours d'Emin Pacha*, in which he mentions three separate falls. The first he describes as "an immense cataract of which we hear the roaring resound in all its amplitude," and he named it and its rapids "Chute Augusta-Victoria." The second cataract, he states, comes down in the form of terraces and is 328 feet in height. He calls it "une chute des plus puissantes," and he named it after H.R.H. the Grand Duke of Saxony, "Chute Charles-Alexandre." The third, of which he gives no details, was located two leagues above the latter, and he gave it the name of Schweinfurth.

The latest edition of *The South and East African Year Book and Guide* (1935), an admirably complete publication in all essentials for travellers in those parts of Africa, does not appear to mention any of the above falls. It does speak, however, of some unnamed falls at the junction of the Tana and Maragua Rivers, of which it says that a hydro-electric scheme to harness them for the cheaper provision of electricity for Nairobi and the Fort Hall area was vetoed in 1930 by the Colonial Office as the falls are in Native Reserve lands. *En passant*, we may note in Kenya Thomson's Falls, which drop 243 feet and are not unlike a smaller edition of the Howick Falls, which I shall describe later.

Continuing further southwards, we find that the Tanganyika Territory, and especially the south-eastern end of the lake of that name, is particularly prolific in fine falls. Of most of these even to-day very little is generally known, but the one which has aroused the most interest in recent years is the Kalambo Fall on the river of the same name, which occurs at a point where the latter forms the boundary between the Tanganyika Territory and Northern Rhodesia.

Some views of these falls, together with a short note, were found among the effects of the late Mr. James Scott-Brown, who died in German East Africa in 1924, he having been taken prisoner by the Germans during the war, and it was at first mistakenly supposed that they were quite a new discovery as they had not then, apparently, been marked on any existing map. It was subsequently discovered, however, that they had long been well-known to residents in Abercorn and the neighbourhood, and that the photographs in Mr. Scott-Brown's possession were copies of some that had been taken by Mr. W. E. Owen in 1913, he having first heard of the falls in 1908. In his note above referred to, Mr. Scott-Brown assessed their height at some 1200 feet, but it has since been found by Mr. J. W. Cornwall, R.A., during a survey made in 1928, that the correct figure is 705 feet. This also agrees with the measurement separately made by Mr. C. B. Frost, to whom I am much indebted for the view here reproduced.

The late Mrs. Gordon-Gallien who accompanied the surveying expedition of 1928 has left a vivid account of the falls, which appeared in *The Geographical Journal* of July, 1929. " As the water plunged over the cliff," she writes, " and fell more than 700 feet to the gorge below, it looked like a sheet of liquid snow. The surrounding cliffs were sandstone-russet, and red, apricot, violet and gold, a veritable Joseph's coat of many colours. Blue and white Marabout storks lived on the cliff ledges or floated over the gorge, shining as steel in the sunlight. A mass of vegetation grows underfoot and on the cliff face. Some short distance

Photo by courtesy of Mr. [illegible], F.R.G.S.

THE KALAMBO FALLS

Height [illegible] feet

downstream are two further falls, one about 50 feet high, the other about 27. Below the gorge closes into a narrow pass with extremely high straight walls."

Captain Harmer, who also contributed some details of the falls to the same Journal of January, 1929, states that 8 feet from the edge of the abyss the water narrows to 20 feet, dropping one foot, and then continues for 8 feet into an opening no more than 6 feet wide, which in itself falls 2 feet 6 inches on to a ledge 12 feet broad and a foot wide. It is this ledge, as he explains, which helps to throw the volume of water out for some distance to the valley below. He further says that about 80 feet from the bottom the water is dispersed into heavy rain. The dry season width above the falls is given as being about 30 feet with a flow of approximately 668 cusecs. In flood, however, the volume may be increased by ten times the above amount, the stream then having a breadth, from all indications, of 60 feet. The gorge itself is stated on the same authority to be 900 feet deep, with a width at the top, till it reaches the lake shore, of 1800.

As will be noted, the Kalambo River is a comparatively slender stream, and there appear to be several falls in the same region which are far more imposing. Thus, on the Ieisa River Captain Harmer mentions the Chirombo Falls, 20 feet wide and 880 feet high, which at 430 feet down are given a jump forward by a narrow horizontal ledge. He describes them as a far more wonderful sight than those of the Kalambo; an opinion which the natives evidently shared, as they referred to the Chirombo as "ukalambo," meaning "big," and to the Kalambo as "unono," or "small."

In their descent over the escarpment down to the lake there appear to be no less than fifteen separate groups of falls which are distributed, as Captain Harmer tells us, over a distance of 2 miles below the main one. The waters, he says, rush with tremendous force through many caves, and it is common to observe water pouring out of a fissure in a huge boulder and dropping 30, 40 or 50 feet, while the main stream runs some 20 or 50 feet away. Dense vegetation clothes the sides of the gorge down which the river plunges.

The Namkali on the Lunzua River and the Tchena on the Lucheche River, both about 30 feet wide with drops of 26 and 18 feet respectively, are other minor falls which he mentions, the former having an immense volume. The Lunzua also disappears underground before entering the lake. Not far from the

Chirombo Falls, he further mentions those of Msmela on a river known as the Lofu, which drop "a few hundred feet."

Other Northern Rhodesian falls which have been noted by Mr. F. E. Kanthack are those on the Lusenfwa, or Lunsemfwa, River, and the falls of Mulungushi. The former are described as having a drop of about 400 feet, but in several plunges. The Mulungushi, by the way, whose height he does not give, but which appear from a photograph to be formidable, suffered the indignity of being harnessed almost as soon as they were first known, or, at any rate, before any knowledge of them had reached the world at large.

Turning to the neighbourhood of Livingstone, near which, of course, are the Victoria Falls, Mr. Farquhar B. Macrae has described in the *Geographical Journal* of July, 1930, and July, 1931, some further "unrecorded waterfalls" which occur on various streams that pour into the Zambesi below the great cataract. Among them are the Chiengkwasi Falls on the Kalomo River, which occur between 7 and 10 miles above the confluence, and are not unlike a miniature edition of the Victoria Falls themselves.

At this point the river enters a narrow gorge, where its width decreases from a quarter of a mile to 150 yards. It then plunges down into a crack which runs across the river-bed, deepening from left to right to a maximum of 100 feet; whence it again rushes out forming another fall about 20 feet high through a narrow fissure, thus having a total drop of 120 feet. As in the case of the Victoria Falls, the lip of the crack is dry for most of its extent except in the rainy season.

Another fall mentioned by Mr. Macrae is the Chilo Cha Basokwe, a delightful name meaning "the sleeping-place of monkeys," on the Namakunza River, which drops 215 feet. This odd name probably led him to christen another hitherto unknown fall Chilo Cha Sikamafwa, or "the sleeping-place of swallows," owing to the large number of those birds in the vicinity. These falls are situated some distance to the east of the Chiengkwasi Falls, on the Chunga River. He estimated their total height—they are a series of falls rather than one single fall—at 334 feet, the main drop being 200 feet with a width of 60 feet at the crest. And lastly he notes a succession of falls which occur between immense cliffs of basalt on the Chisi or Chibongo River, another tributary of the great Zambesi below the Victoria Falls.

There are also, six miles below the latter, the falls on the Masuve

Photo by courtesy of the High Commissioner of H.M. Eastern African Dependencies

THE UPPER PART OF THE ZON FALLS

River, which plunge down into the great gorge of the Zambesi for 300 feet; but they are not especially impressive except after a good deal of rain.

I have already mentioned the Murchison Cataracts on the Shire River which issues out from Lake Nyasa and eventually joins the Zambesi after a course of some 370 miles. The last and most southern cataract, named the Murchison Falls, after Sir Roderick Murchison, is said to be the finest, but I have no details as to its height. It is on the Ruo River, however, a tributary of the Shire which joins it at Chiromo on the Anglo-Portuguese boundary, that the most notable falls in the Nyasaland Protectorate occur, namely, those of Zoa, about 25 miles from the river's mouth.

They were first, I think, described by Mr. John Buchanan, then H.M. Acting Consul at Chilomo, in the *Geographical Journal* of May, 1891. He states that they have a leap of some 200 feet into a foaming abyss, whose depth he had no means of estimating. He found the width of the river at that point to be about 200 yards, but much more from bank to bank across the face of the falls. Their general outline is like that of a horseshoe. Near the left bank he found a chasm 60 yards in length by 30 in width, with a depth of 200 feet, above which stood a huge mass of rock, and from behind this, and over its face, the river pours in a tremendous cataract when in flood. From the chasm to the right bank there extends a wall of rock cut into terraces.

"At the time of my first visit," he writes, "the water from various channels collected into one main stream, which thundered down the chasm, foaming and tossing between its walls, sending heavenwards clouds of vapour, and in emerging from its confinement dashes itself out into a breadth of 150 yards and continues its angry course, impinging on rocks and boulders till reaching Nakale, where it composes itself into dark-blue lakelets, tempting indeed to the heated traveller."

The face of the fall was indented with several large and small pot-holes from 18 inches to 10 feet in diameter, and from 1 to 10 feet deep. Many round and kidney-shaped stones lying at the bottom of these gave evidence of the water's action. These falls are situated at an elevation of between 1400 and 1600 feet above sea-level.

I have already alluded to the streams which descend on either side of the great Drakensberg range in my chapter dealing with the Aughrabies Falls. Here the Giant's Castle and the Mont aux Sources rise respectively to over 10,000 and to 11,150 feet, while just within Basutoland the Cathkin peak soars to over 12,000. Apart from the leap of the Maletsunyane, which I have described, on the Basutoland side, that of the Ketane, 400 feet or so in height, has surroundings scarcely less impressive.

The name Mont aux Sources, which is not, by the way, itself a peak, but rather a bleak moorland plateau, was given to the mountain mass in question by the early French missionaries of the original Cape Colony because this point in the range is the watershed of three large river systems. Down the tremendous rampart on the Natal side the infant Tugela leaps off, eventually to find its way to the Indian Ocean. To the south-west the Orange and the Caledon and their many tributaries pour into Basutoland ; while to the north flows the Elands River, an affluent of the Vaal which, later, itself joins the Orange.

The barren, shelving expanse of moorland where the Tugela takes its rise reminded me much of parts of Dartmoor. It traverses about 3 miles before it comes to the brink of the immense amphitheatre over which it plunges, and though joined by several tiny rivulets it is still no larger than a moderately sized brook at the point where it cascades down to the edge of the precipice. Here it jumps off into space, making a total drop of 2810 feet, consisting of about five sheer leaps in the clear with several slanting descents between them.

Unfortunately on the day on which I ascended from the Mont aux Sources Hostel, 4800 feet above sea-level, to the top of the amphitheatre, the weather was most unfavourable. A thick Scotch mist came down, blotting out almost entirely the magnificent views on either side, and it continued to hang over the mountains for the greater part of the succeeding day as well, and only cleared, indeed, aggravatingly enough, as I again descended to the hostel late on the latter afternoon. The trek up from the hostel to the summit involves an ascent of over 6000 feet and covers some 14 miles. It presents no difficulty, and, given clear weather, displays some of the finest scenery in all South Africa.

As I at length stood at the edge of the fall, however, gazing down into the abyss below, nothing could be seen except the first and upper leap of the cascade which then disappeared into, and was swallowed up by, a mass of fleecy clouds, pierced here and there by the enormous black buttresses and spurs of the precipice. The hut of the Natal Mountain Club, which stands a few hundred yards back from the edge of the amphitheatre that extends for 5 to 6 miles from the Eastern Buttress on the right to the Sentinel

Photo by courtesy of Miss F. [illegible]

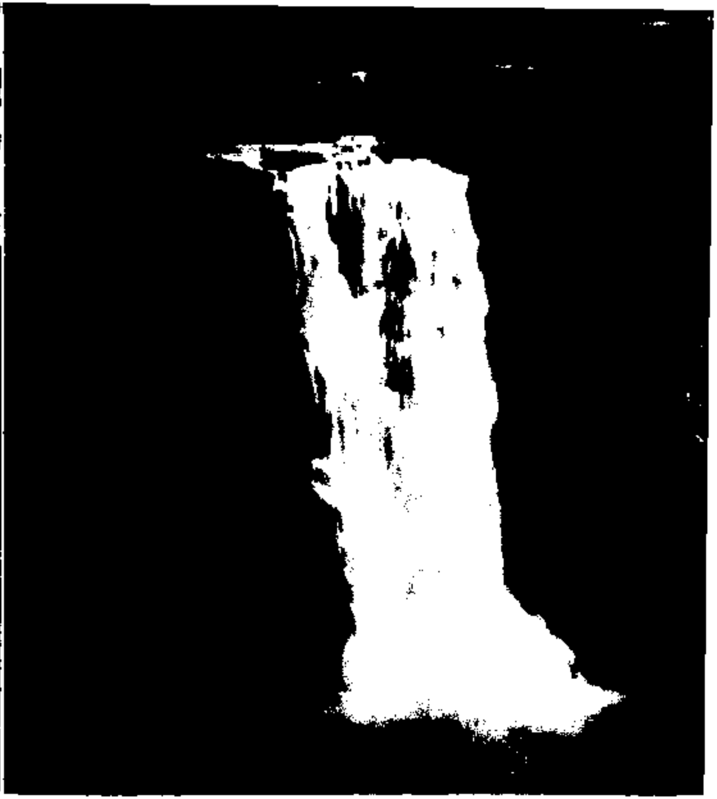

Photo by courtesy of the South African Railway

on the left, is devoid of the slightest convenience of any kind and makes but a sorry comparison with similar tourist huts in Norway and elsewhere.

I spent one of the most uncomfortable and sleepless nights that I ever remember in it. It consists of two sleeping-rooms, each containing a very broad and excessively hard bed on which no more than four persons could lie with any comfort, and between these is a third room provided with a stove and a dining-table. As our party numbered eleven, apart from three Basuto guides, the congestion may be easily imagined. The draught of the icy-cold mist through the small broken windows did not further conduce to slumber in spite of the number of blankets we had taken with us. There were no toilet facilities of any kind whatever, and the extremely crude shrine to Cloacena consisted of a wretched separate hut fully 100 yards distant across the open wind-swept moorland.

Considering that this pilgrimage, if I may so term it, is one which is being undertaken by an increasing number of tourists every year, and is justly considered to be one which affords views of the finest scenic grandeur imaginable, it is surely high time that something better was provided. I understand, however, that this is shortly going to be done, and that the hut would indeed have been far more commodious and better appointed in the first instance had its constructor not been limited to a quite insufficient expenditure, much against his will and advice.

Not the least of the attractions during the ascent up to the Mont aux Sources was the wonderful variety of flowers by the way. Apart from numerous proteas, or "sugar bushes" as they are locally named, many of which were still in bloom on the higher slopes, I noticed at least eight different varieties of orchis, not to mention dianthus, pelargoneum, nemisias, cinerarias, irises, lobelias, agapanthus, myosotis, tritomas, scabies and various succulents, and some very pretty pale orange papaviers.

Two much less arduous and very charming walks, also in the National Park, are those to the Gudu Falls and to the gorge and so-called tunnel of the Tugela below its great leap. The former are perhaps 100 feet in height and of small volume, but their setting as they plunge into a romantic dell is extremely lovely. The stream first pours down through a cleft cut into the summit of the cliff and then leaps out clear into a deep pool. In the surrounding woodlands are splendid yellow-wood trees, thick clumps of the dark green amantingulu, and last, but not least, masses of wild begonias of a pale orange-pink hue everywhere sprouted from the moss which carpeted enormous fallen boulders. There was, besides, a profusion of lovely maidenhair ferns. A deep recess hollowed into the rock enables one to pass behind this fall.

But finer still is the well-known Tugela Gorge and Tunnel. In front, as one ascends the narrowing valley of the river, there is almost constantly before one the enormous serrated wall of the vast amphitheatre over which the Tugela leaps, flanked, as one faces it, by the towering Sentinel and the Beacon Buttress to the right and by the Eastern Buttress to the left. Going up the valley I passed through half a dozen separate woodlands which stretched down the hill-side, all delightfully cool in their shady recesses after the heat without. Here again the wild begonias were massed in profusion. At length the valley contracted into the remarkable gorge which extends for from 200 to 300 yards up to the mouth of the tunnel.

Immense cliffs, in places black and grey and salmon-pink, soared up for hundreds of feet on either side, over the left-hand one of which two tiny rivulets cascaded in fine spray. The bases of these great precipices were for the most part cylindrically hollowed out, and between them the as yet small Tugela babbled along among great blocks of fallen rocks. Just below the exit of the tunnel whence it emerged, another stream of about equal size flowed into it on the right bank, coming from the direction of the Devil's Tooth, a sharp needle of rock seen far aloft near the Eastern Buttress.

The tunnel, which is not a true tunnel as it is not entirely roofed over, extends for about 150 yards. Its bed is a succession of deep pools connected by slanting chutes of purling, cold water over slabs of rock worn perfectly smooth and devoid of sand or pebbles. The vari-coloured walls, like those of the gorge, are hollowed at their bases and arch overhead, almost, but not quite, meeting. Here I had to discard my clothes to wade and swim through to the upper end where the stream poured in, forming a low cascade. From there it was about a mile to the foot of the main Tugela Falls, and very rough and uneven going over the rocks in the bed of the river.

But one could write pages about the beauties of this fine National Park, within whose limits it is scarcely an exaggeration to say that one could take a different walk for every day of the year and still see something new. The well-appointed hostel, by the way, with its numerous Rondavels, is admirably run, and the charges are most reasonable. I can think of no more ideal spot to spend a holiday than this, if the right time of the year be selected.

Among the best known falls in Natal, and considered by many to be one of the finest in Southern Africa, are the Howick Falls, close to the township of Howick and just off the main Durban-Johannesburg road. There has long been a local tradition that they are as many feet high as there are days in the year ; but this, as I discovered, is rather an exaggeration, the correct height being about 320 feet.

The Umgeni River here falls sheer over a precipice of black rock, flanked by russet-hued cliffs, into a deep pool below, emerging from which it flows straight on for a few hundred yards and then turns down a deep and well-wooded valley to the right. A steep pathway leads down to the foot of the falls, descending in places over rough natural steps cut in the rock. At the time I saw the falls the river was low, apart from which they have for some time been harnessed to supply power to a factory which manufactures motor tyres and other rubber goods. On one occasion since then there was no water passing over them at all. When in flood, however, the river surges along in great rolling masses and hurls itself in fury over the cliff with a noise like thunder, affording an extremely fine spectacle.

There has been more than one tragedy here. Some years ago an Indian peasant woman, who was washing clothes in the river a short distance above the brink of the falls, let one of the garments slip out of her hand, and in an effort to regain it lost her balance and was carried over. Oddly enough, she did not fall right down to the bottom, but her body became lodged on a projecting shelf of rock some distance below the crest, and there remained for a considerable time. Some English soldiers happened to be then encamped near-by, and one of them made a bet of ten pounds with another that the latter would not recover the corpse. The story goes that he succeeded in doing so, after being let down with ropes, and then promptly spent the ten pounds in a violent drinking bout to celebrate his success. His potations, however, combined with the recollections of the nauseous task of bringing up the decomposed corpse, so preyed on his mind that he became quite insane afterwards.

Far finer, to my mind, than the Howick Falls are their near neighbours, the Kharkloof Falls, some 10 to 12 miles away and situated on the Kharkloof River, one of the Umgeni's tributaries. On the morning that I motored to them, or rather to Mr. Simonds' Farm, who kindly allows visitors to pass through his fields to see them, the by-road I had to traverse was in an appalling state after rain and I doubted if I should ever get to them. Eventually I did so, however, and was more than repaid for the hair-raising "skids" I experienced *en route*. Their surroundings are far more lovely and impressive than those of the Howick.

After descending over some minor cascades, the river plunges for 343 feet into a magnificent gorge, flanked by tremendous precipices of sheer rock. Not only are they higher than the Howick Falls, but their crest is much wider, though only part of it was water-covered at the time I saw them. The volume then appeared to be much the same as that of the Howick, though the latter has probably the greater mean annual discharge. Mr. Simonds told me that when in flood they presented one of the finest spectacles he had ever seen of the kind, the whole valley being filled with clouds of spray which swirled upwards over the tree-tops to the accompaniment of a deafening roar. The drop is practically sheer and, generally speaking, the face of the fall much resembles that of the Howick, though it is slightly broken by a ledge of rock some 60 feet down from the crest, and by another horizontal ledge at the base immediately above the pool. I should doubt if Natal boasts any finer falls than these.

Other less important falls within easy reach of Howick are the Shelter, the Cascade, the Edendale and the Albert Falls, of which the latter, also on the Umgeni, are the most considerable.

Of the various falls in the neighbourhood of Durban those of Nongwam are generally reckoned to be the most beautiful. They drop over a ledge for about 200 feet, and are remarkable for a huge isolated column of rock near the base of the fall which towers aloft like a sentinel. The forest and virgin bush which surrounds the pool into which they plunge and clothes the sides of the ravine, lend an additional charm to the very lovely setting of these falls.

Other pretty falls which I can do no more than mention here are the Luhrana River Falls, the Ensinyati Falls, the McIntosh Falls and those of the Shongweni, which latter, however, though of considerable height, had but a very slender volume at the time of my visit to them. I may also mention here the imposing falls on the Umkomass River, situated about 50 miles to the south-west of Pietermaritzburg.

Coming down to Cape Province, and passing over some noteworthy falls near Umtata, on the Umtata River a few miles below the township of the same name, the last important falls we may mention on the eastern side of Africa are those of the Tsitza River, about 40 miles north of Umtata in Pondoland, which are said to be the highest in Cape Province. They fall over an almost vertical precipice over a hundred yards in width to a depth of 380 feet and have a considerable resemblance to the Rainbow Falls section of the Victoria Falls. It has been stated as a peculiarity of these falls the eels abound in the reaches of the Tsitza above them, and in what manner they have overcome an obstacle which is apparently so insuperable has been a puzzle to many naturalists.

Before reversing our route from south to north and proceeding up the western side of the continent, we may just glance at some of the aqueous leaps in the islands of Madagascar and Mauritius. The most impressive waterfall in the former island is probably the one on the Matitanana River in its south-eastern district. The falls are situated from 40 to 50 miles inland from the Indian Ocean as the crow flies, and not far from the village of Ivohitrosa.

The account of the Rev. James Sibree, D.D., who spent over fifty years in missionary work in the island, is the only one I have been able to find as regards these falls, which, furthermore, he was unable to approach any nearer than some 3 to 4 miles. They occur at the head of a valley which opens into what he terms a great bay or hollow running up into the higher level of the country. This bay is surrounded with wooded hills rising up from 2000 to 3000 feet above the valley floor, and on his way to the village he counted from four to five falls pouring over the heights, two of them "falling in a long ribbon of foam several hundred feet down."

On leaving Ivohitrosa the following day and climbing a spur on the other side of the valley, he was able to obtain a good, though distant view of the main fall. The Matitanana here plunges down over a semicircular wall of rock crowned with dense forest in a single leap, which Mr. Sibree estimated, knowing the heights of some of the neighbouring hills, could not be less than between 500 and 600 feet. The body of water, he states, was large, and from the foot of the fall there rose a continual cloud of spray on either side, like smoke, with a roar which reverberated up the rocky sides of the valley. Even from the distance at which he saw it, it struck him as a very grand sight.

He goes on to relate how he made two or three attempts to ascend the valley so as to get nearer to the fall, but was stopped by bogs and impenetrable bush. The natives, as I have before mentioned in connection with other notable waterfalls, were also clearly unwilling that he should get to it on account, as he says, of some superstitious dread of the place. At least, he could not induce any of the inhabitants of the village to accompany him or even to give him any assistance, and they declared that no one had ever been to the foot of the fall, and that the paths were all difficult. His visit to the place was sometime prior to 1876, so that it is more than probable that other travellers have since got right up to the cataract, though I have not been able to find any record of it.

M. Henry D'Eschamps says of the Matitanana River that it is as sacred in the eyes of the Malagasy as the Ganges is to the Hindoos, and that the meaning of the name is the River of the Dead Hand, from *mati* meaning *to die*, or *dead*, and *tanana* meaning *hand*. According to local tradition the name originated from a contest between two enormous giants who, standing on opposite banks of the stream, started quarrelling with each other. One of them is said to have gripped the other's hand so violently that it became detached from the arm and fell into the river! Whence its name.

There are several pretty cascades in the small island of Mauritius, but none, of course, of any very impressive volume except after very heavy rain. Among them may be enumerated the falls of Chamarel, of Dya-Mamou, des Galets, Savane, and the Cascades des Tamarins or of the date trees. The former, which are situated on the Rivière du Cap in a branch range of the Savane Mountains, drop over a rocky ledge to a depth of 320 feet, and are said to be remarkably fine in the wet season.

The Savane Cascades, which pour over a wall of black basalt, are exceptionally lovely on account of the very numerous angular projections which the water encounters in its descent, which break it up into scores of jets and spurts that are flung back from point to point in showers of spray, sparkling like jewels in the prisms of the rainbows. Then there are the Tamarind Falls, seven in all, which are formed partly by the Tamarind River and partly by other streams which join it at this point. Their united height is over 300 feet. The basaltic or lava steps over which they descend are set off on either side by the most gorgeous vegetation. But the finest waterfall in the Island, though of considerably less height than the Chamarel, or Tamarind, Falls, is probably that of Dya-Mamou on the Grand River.

Mr. Nicholas Pike, who was at one time American Consul at St. Louis, and who saw them at a period of high water, describes them as thundering into the gorge below with "terrific sublimity." The torrent pours over a basaltic wall of rock, falling for about 100 feet on a width of 50 feet. Above the falls at a little distance up, the stream is about 200 yards wide, but shallow, and its bed is filled with rocks over which the water rushes forming rapids "like miniature Niagaras." The banks of the river are enclosed by dense forests through which it is no easy matter to make one's way.

The falls on the des Galets River are nearly 300 feet in total height, but are much broken up by immense jagged rocks, which are covered with ferns and mosses.

Returning to the African mainland and proceeding up the western side of the continent, with the exception of the Aughrabies and Rua Cana Falls already described, there appear to be none of any note till we come to Angola. The latter country boasts a considerable number of waterfalls, but the majority of them are very little known and information regarding them is scanty and difficult to obtain. Most of the falls are on tributaries of the Congo and Coanza Rivers, and one of the most imposing on an affluent of the latter, namely, the Luando River, is situated about three days' trek north of Cuemba, a station on the Lobito Bay-Tenki railway, and about 490 miles east of the former. Few people have as yet seen this fall, which is within some 50 miles of the region where the great sable antelope is found.

The river, after traversing the plateau, drops about 220 feet into a beautifully wooded gorge. It is of considerable volume, and about 200 yards above its leap has a width of 100 yards. On the left-hand side, facing downstream, the drop is much broken about half-way down by immense masses of rock, but on the right side it has a sheer leap. Below, the river descends over numerous rapids down the gorge.

Near Cuemba station itself there are some lesser falls on the river of the same name which have, however, been harnessed to supply power to a sisal factory.

On the Lucala River, another tributary of the Coanza, are the Lianzundo Falls, which are sometimes also known as the Duke of Braganza Cataract, owing to the river flowing past an ancient fort of that name some miles above its leap. They are of considerable volume, though scarcely 100 feet in height, and are distinguished by dense thickets of orange trees which clothe the river's banks below them.

Another Angolan waterfall, which unfortunately I had no time to visit, occurs on the Hanha River, which enters the sea a little north of Lobito Bay. At the point where I saw it, namely, at Hanha do Norte, where I visited a palm oil factory and a magnificent palm plantation, the river was broad and deep, and the falls, which I was told drop some 95 feet, were about 7 miles farther upstream.

Below Hanha do Norte, the river flows through a tremendous gorge, its banks lined with dense clusters of palms. On the summits and in the cavernous recesses of the towering limestone cliffs on either side numerous baboons have their haunts, whose hoarse barking echoes from one side of the valley to the other. One of them, annoyed at our intrusion, hurled down a large stone at one of my companions, which missed him by only a few inches. This gorge, a few miles from Lobito Bay, is a favourite resort of picnickers, and is certainly one of the most picturesque that I saw in Africa.

It will be convenient here to mention one or two falls in the Congo Territory, where there are, no doubt, a considerable number of which, like those in Angola, very little is known even to-day to the outside world. Two of these, which are of no great height but of large volume, are the falls on the Lulua River and those of Tschala on the Sunkuru. The first are at Katende, near Luluaburg, in the Kasai Province. The Lulua, which is a tributary of the Kasai, here pours in slanting cataracts into a narrow gorge, the water descending in furious waves. The vertical drop is no more than from 30 to 40 feet, but it provides an impressive spectacle.

The Chutes of Tschala on the Sunkuru River, here known as the Lubilashe River, are remarkable in that, though half a mile wide above its leap, the stream is confined below it to a breadth of only 25 feet. The ravine into which it plunges is flanked with smooth, water-worn rocks in which there are numerous hollows and deep cavities, and the total drop is said to be between 60 and 70 feet. These falls have been harnessed to supply power to the Lukulenga diamond mines.

Other falls that may be mentioned are the Kalundini and the lower Kaii Falls, both on affluents of the great Lualaba.

Coming to French Equatorial Africa, M. Alfred Marche has recorded some low though impressive falls on the great Ogoway River, known as the Chute de Bôoué. He describes them as being not far short of 40 feet in height, but noteworthy in that the river, which is some 1100 yards wide about a third of a mile above the falls, is contracted at its leap into *un entonnoir de roches* no more than 55 yards in breadth, and towards the left bank. Into this channel, shaped like a horseshoe, the stream, he states, rushed with incredible rapidity, boiling up in the pool below in a kind of vortex which it made him giddy to look at.

It is on one of the main affluents of the Ogoway, namely, the Ngounie, that Paul du Chaillu described some falls which he calls the Samba Nagoshi Falls in his book, *A Journey to Ashango Land*. But though he states these were 150 yards in width, divided by an island into two unequal parts, they were of no height, and it was the rapids below the falls which appear to have most impressed him. These latter he describes as "a torrent of fearful velocity and grand proportions, leaping in huge billows, as though the whole of the water of the river dropped into a chasm and bounded out again, over ridges of rock," etc. This is the same river which he calls the Ngouyai.

Turning to the French Mandated Territory of the Cameroons, a notable fall occurs at Edea on the Sanaga River. It is situated some 50 miles from Duala, on the route between that town and Yaunde. The river is one of the largest and deepest in the Territory, and the falls are set among the most gorgeous tropical vegetation. They are said to drop about 130 feet, and to be remarkably fine. I much regretted that while in Duala a short while ago I had no time to go to see them. The road was said to be bad, and moreover no motor car happened to be available.

In the numerous wooded ravines of the Cameroon highlands, whence a great number of streams descend in all directions both to the coast, to the Congo and Niger basins and to Lake Chad, there are said to be many fine waterfalls, notably the falls of Big Batanga ; and one would like to have time to explore the region thoroughly. The majestic Great Cameroons Mountain, rising up over 13,000 feet beyond Victoria, impressed me as by far the finest and most alluring bit of scenery on all the West African coast.

Proceeding to Nigeria, we must note the falls of Ferin Ruwa, of which a note appeared in the *Geographical Journal* of February, 1933, by Mr. R. C. Niven. They are placed in the northern highlands of the country round and south of Jos, a region known as the Plateau. In the south-west escarpment of the latter the Ferin Ruwa (or "White River") has cut a deep valley with a wall some 2500 feet above the plain on its eastern side, and it is in a right-angle formed by this wall with another trending to the west that the falls occur.

Mr. Niven states that they can be seen 40 miles away. They are narrow at the top but spread out at the foot, the wall of white falling water seeming to overhang the spectator. As regards their height, Mr. Niven writes: "Were they vertical, as the visible falls are estimated at over 800 feet in height, they would be among the world's great falls, but though parts are vertical, the average slope is probably less than 60 degrees."

He describes the face of the falls as being over granite veined with basalt of the plateau, and further says that the water is often discoloured by the tailings from tin workings in the river's upper reaches. Above the falls the stream flows through an extremely steep gorge, parallel with the face of the escarpment, at the upper end of which is a pool into which there pour down three separate streams forming minor falls of a height of some 300 feet. In the rainy season the river has a breadth of 100 yards with a very swift current, though it can be forded at low water.

The last fall of any consequence to be noted on the west side of Africa is that of Felou on the Senegal River. The falls occur at a point distant some 620 miles up from the sea and not much more than 260 feet above sea-level. They are no more than between 50 and 60 feet in height and the discharge in the dry season may fall to less than 2000 cusecs.

During the flood period, however, which lasts from June or July to October, the stream may rise in places from well over 30 to close on 50 feet, rendering the falls at that time a decidedly imposing spectacle. Above its plunge, the river forms a lake-like expanse owing, as in the case of Tisisat, to the barrier of rocks at the crest of the falls, of which two particularly stand aloft like black obelisks in the midst of the foaming waters, a feature which we have already remarked in the case of the Chute de Pancada on the Rio Yary in South America.

Through this rocky barrier the water pours down in various narrow channels into a pool strewn with rocky islets, here and there overgrown with trees. Some distance above Felou there are other falls, on the Senegal namely those of Gouina, with a height of approximately 50 feet on a width of 500 yards.

In concluding our review of the notable waterfalls on the

African continent, I shall mention lastly the falls of Mefrouch in Western Algeria, which occur on the river of that name, sometimes also known as the Saf-Saf. M. de. Lorral has given a good description of them in his account of *le Pays de Tlemcen*.

"All of a sudden," he writes, "the scene changes and a magnificent spectacle lies before us. We come out on the valley of the Saf-Saf, also known as Mefrouch. Opposite on a rocky terrace one catches a glimpse of the little Arab village of Moulalou where at one time Abd-el-Kader owned gardens. Following the same line of view, there soars aloft the Djebel Hanif (1298 metres), whose imposing mass dominates all the countryside. At our feet lies an abyss which passes around Lamoricière and Sidi-bel-Abbès. At the bottom of it the river rushes amidst a veritable forest of wild cheery trees ; on our right, still hidden by the spurs of the mountain, roar the cascades. We wind our way along a giddy path notched in the mountain which sometimes overhangs us. Here and there, there is a bay filled with fruit gardens where there are fig trees. We seem to hover at such a height that our eyes can scarcely discern the goats and the sheep far down among the rocks. . . . At the foot of the upper cascade, the most beautiful of all, the view is truly splendid. The river glides over an oblique surface ; its waters are divided into five crystal sheets of which two fall directly opposite the spectator. The other three plunge down towards the right side and go to swell the first two. The effect is arresting. The water, shattered by the violence of its fall, rebounds in impalpable rain."

Above the falls the stream is divided into two branches which flow around either side of a small islet, a green oasis on which all kinds of fruit trees flourish ; but on the further side of the river there is nothing but a vast desert, "not even a tree to soften the view."

CHAPTER XVI

THE GIANTS OF ASIA: THE KHON CATARACTS ON THE MEKONG, AND THE FALLS ON THE CAUVERY AT SIVASAMUDRAM

WITH the exception of the Khon Cataracts and the falls on the Cauvery at Sivasamudram there are, strictly speaking, no giant waterfalls in Asia whose dimensions in combined volume, height and width can compare with such giants as, for example, Niagara, the Victoria and the Iguazu Falls; and, moreover, even the Cauvery Falls may dwindle to a very slender stream at dead low water. But, as in the case of the South American giants, I have included Kaieteur among them, though its mean volume is much less than that of the others, so here I shall include Gersoppa among the giant falls of Asia, both on account of its height and its surprising volume during the rainy season of the monsoons.

The Khon Cataracts, as I have already indicated, consist for the most part of gigantic rapids rather than of true waterfalls, but as the sheer vertical heights of at least three of these cataracts vary from nearly 50 to 70 feet, the latter at any rate are certainly entitled to be classed as falls.

The Mekong is both the longest and greatest in volume of all the rivers of Indo-China, its total length from the point where it takes its rise in the Kham division of Tibet to its extraordinarily wide delta, which has a frontage on the China Sea of as much as 370 miles and more, being estimated at 2800 miles. It is, therefore, one of the very great rivers of the world. In its upper course, where it is known as the Dza-Ch'u and sometimes as the Lan-tsan-kiang, it flows through tremendously deep gorges. The peaks which divide its valley from the parallel one in which the Yangtze flows to the east of it, attain to as much as from 20,000 to 21,000 feet; while the sharper and more graceful mountains which separate it from the valley of the Salween on the west are but little less.

Like that of the Yangtze, its upper valley, of which the sides consist of mighty walls of red sandstone, is extremely arid, but the change from desert to forest further south is markedly abrupt and takes place within a distance of a few miles. It is below Ch'amdo where the last bridge, known as that of Szechwan, crosses it, at a point where the river is only 60 yards wide, that the Mekong becomes the great river of Indo-China; for at the latter point it is joined by the Om Ch'u, while, some distance above, the Dze Ch'u, the Bar Ch'u, the Dje Ch'u and a number of other streams all contribute to swell its volume.

Owing to the sandstones above mentioned, the Mekong in its flooded state in summer becomes a thick reddish yellow colour, but by November its waters again assume a clear bluish tint ; for in the winter the headwater streams which drain the upper sandstone plateau become frozen in the higher valleys, when the rivers are fed mainly by the perennially clear streams which issue from the underlying limestones in the north. The river is usually in flood from August to October, when the rise in places may reach from 30 to 50 feet.

The Khon Cataracts occur about 400 miles up from the mouth of the Mekong and are caused by a barrier of rocky and, for the most part, thickly wooded islands stretching across the river, which, from one true bank to the other, is here reckoned to have the immense width of from 12 to 15 miles. Our chief authorities for an account of them are Lieutenant Garnier and M. Delaporte, an artist, both of whom accompanied a French expedition up the Mekong in 1866, 1867 and 1868 under the charge of Captain Doudart de Lagrée, an officer in the French Navy.

It is on account of their enormous volume, alone rivalling that of Guayra, that the Mekong Cataracts are especially notable. Lieutenant Garnier reckoned the discharge at Bassac, about 62 miles above the falls, to be about 317,833 cusecs in the month of December at comparatively low water when the river had already subsided not far short of 30 feet ; and he calculated that at high flood it would, as in the case of Guayra, attain to 50,000 cubic metres or 1,765,738 cusecs. Reclus expresses the opinion that at its mouth the mean flow of the Mekong cannot be less than 12,000 cubic metres per second (i.e. 423,777 cusecs), and that in very high flood it might attain to 60,000 or even 70,000 cubic metres (i.e. from 2,124,885 cusecs to 2,472,032 cusecs).

In an abbreviated account of the explorations of the abovementioned French expedition, the anonymous author of a book entitled *The French in Indo-China* remarks :

" The Cataract of Khon is really a series of magnificent falls, of which the grandest is caused by the confluence of the Papheng. There, in the midst of rocks and grassy islets, an enormous sheet of water leaps headlong from a height of 70 feet, to fall back in floods of foam, again to descend from crag to crag, and finally glide away beneath the dense vegetation of the forest. As the river at this point is about 1000 yards wide, the effect is singularly striking. But still more imposing is the Salaphe Fall, which extends over a breadth of one and a half miles, at the very foot of the mountains. In order to examine it at leisure Lieutenant Garnier engaged a Laotian to conduct him to an island just above it."

After describing how the former was attacked and bitten by hundreds of leeches, while the native, who had plastered himself with a mixture of lime and areca nut juice, escaped that annoyance, the writer continues :

" He (Lieutenant G.) felt more than repaid, however, for all his sufferings when he arrived within sight of the cataract. With a breadth of 2000 yards, a prodigious mass of water came down in blinding foam, roaring like a furious sea when it breaks against an iron-bound coast. At another point, the flood was divided into eight or ten different cascades by as many projecting crags, richly clothed in leafage and vegetation. Beyond, nothing could be seen but one immense rapid—a roaring, tumultuous deluge !

The sandstone blocks and boulders which encumbered the river-bed were completely hidden by the whirl and eddy of the waves ; and their position could be detected only by the foam on the surface, or the vapour floating wreath-like in the air. Further still, a few black points, a few ridges of rock, and a chain of small islets, stretched across to the opposite bank, which it was impossible to approach, and where, apparently, the cataract seemed to attain its greatest fury. Such was the great fall of Salaphe—a scene of sublime grandeur, conveying the idea of everlasting strength and power."

In order to get a good view of the fall of Papheng, M. Delaporte has described how he had to wade across to one of the smaller islands, and there was obliged to cling on to the branch of a tree to get a full bird's-eye view of its whole extent ; and in the case of the Salaphe Fall he has noted how the shock of the furious flood, as it struck the rock on which he was seated, made it tremble to its foundation, and how at the base of the fall he observed huge trees, crocodiles and large fish all broken and shattered in the eddies among the rocks by the immense force of the water.

Lieutenant Garnier thus describes his first approach to the cataracts :

" In ascending the river one comes into an immense and magnificent basin about one and a half leagues in its greatest width with a depth of 40 metres. It is bounded on the north by a compact mass of islands, among which, for the first time, there arise some hills. It is across these islands and by twenty different channels that the waters of the river . . . precipitate themselves into the tranquil basin where they are mingled and hushed. At the western extremity of this basin, and on the right bank, there arises a group of mountains, and one perceives that it is at that point that the rocky barrier begins which has so unfortunately obstructed the river's course.

"On traversing the basin, one sees in succession at the entrance of each of the arms which flow into it, falls of water varying in height and appearance, which veil the horizon with their shifting curtains of spray. The waters by no means fall everywhere in cascades. In some long and winding branches they have worn down the obstructions and flow in rapids. There are channels there of which the natives take advantage to pass through their boats when completely lightened. These passages vary with the seasons, and some remain entirely dry during certain months of the year.

"The two most important channels and the two finest falls are in the two extreme arms of the river, the arm of Salaphe and that of Papheng. There one sees falls of more than 15 metres in vertical height and of a breadth which sometimes reaches to a kilometre. The line of falls extends, broken up into several divisions, over a total width of from 12 to 13 kilometres. Above, the river contracts for a short distance so as not to attain the half of this measurement; then it expands again over an immense plateau of rocks which precede the falls, losing itself in the midst of numberless islands, and embracing between its two banks a space of nearly five leagues. Everything in this gargantuan scene breathes an air of power and is invested with overwhelming proportions."

A further fall, that of Don Isom on another branch of the river, is stated to be about 65 feet, but it is more narrow than that of Salaphe or Papheng. M. Delaporte has left us a drawing of this latter cataract in the volume of maps and sketches accompanying the report of the expedition, which was published by order of the French Ministry of the Marine.

The cataracts, awe-inspiring though they are, are of less height than the Guayra Falls, but at the same time the dense vari-coloured sylvan growth which clothes the numerous islands invests them with a charm which widely contrasts with the barren and savage setting of the latter. Here also, unlike Guayra, which appears to be shunned by all animal life, many of the wooded islands become the haunts of deer and other game when low water renders them accessible, and where, also, when cut off by some sudden flood, they become the prey of the numerous tigers which sometimes get on to them. Pelicans and many other aquatic birds make the spot their home, feeding on the fish which can be seen sporting in the pools below the falls and letting themselves glide and float down the currents without the least fear of the raging waters. Lieutenant Garnier states, by the way, that the forests on the islands were, in his time, of comparatively recent growth, and that the natives could recall the time when they were mostly barren rock.

It is interesting to note that in 1893, for the first time, the French succeeded in bringing a gunboat up the rapids to the upper river; first by one of the winding channels on which no considerable vertical drop occurs, and then by railway across the island of Khon which is the largest of the whole group.

The Cauvery or Kávéri River on which the well-known falls at Sivasamudram occur is sometimes also known as the Dakshina Ganga. It is the chief river of Mysore in southern India and is regarded by the Hindus as scarcely inferior in sanctity to the Ganges itself. It was known to Ptolemy and the geographers of Ancient Greece as the Kaboeris. The river takes its rise in Coorg in the western Ghats, crosses the southern part of the Peninsula, and finally pours into the Bay of Bengal after a course which is variously estimated at from 470 to 650 miles. For a distance of about 40 miles the stream forms the boundary between Mysore on the north and Coimbatore on the south; and it is in this section of its course, where the island of Sivasamudram, or "the Sea of Siva," divides the river into two branches that "the Indian Niagara," as it has sometimes been termed, occurs.

The late Mr. B. Lewis Rice, in his *Gazetteer of Mysore* (1927 edition) has given the following account of the river's divine origin:

"The supposed divine origin of the river is related in the Kávéri Mahátmya of the Agneya and Skánda puranas. She was first Vishnu-máyá, a daughter of Brahma. By his direction she became incarnated in Lopámudrá, a girl formed by Agastya (with the view of her becoming his wife) of the most graceful parts of the animals of the forest, whose distinctive beauties (*mudrá*), as the eyes of the deer, etc., were subjected to loss (*lopá*) in her superior charms. Brahma gave Lopá-mudrá as a daughter to Kavéra muni, whence she acquired the name Kávéri. In order to secure beatitude for her new father, she resolved to become a river, the merit of whose waters in absolving him from all sin and blessing the earth should accrue to him. But when she became of age, Agastya proposed to marry her. To reconcile the conflicting claims, Lopámudrá or the mortal part of her nature became the wife of Agastya, while Kávéri or the celestial part flowed forth as the river."

For about 40 miles from Talakad till it approaches the island of Sivasamudram the Cauvery flows in a northerly direction, and after its junction with the Kabbani broadens out into a stream of between 500 and 1000 yards in width. In its great sweep around either side of Sivasamudram it curves from south-west to north-east, and it is towards the further or downstream end of the island that it forms the famous falls. The northernmost one on the left or Mysore side is known as Gangana Chukki or "Sky Spray," and the fall on the right or Coimbatore side is called Bar Chukki, or "Heavy Spray." Each of these falls is subdivided into two by a small island.

In the case of Gangana Chukki, which is split by the island of Ettikur, the *mean* widths of the two branches, according to the figures supplied to me by the Chief Engineer of the Mysore Government, through the kind offices of Mr. H. D. Rice, Trade Commissioner for Mysore in London, are 580 and 692 feet respectively and the total height 299 feet ; while those of the Bar Chukki amount to 728 and 756 feet with a drop of 182. It may here be mentioned that the total "head" available for power purposes is over 400 feet, and, further, that but few of the many separate shoots of water pour over the precipice in one unbroken sheet in the clear for the whole of the above heights, but they mostly descend at a slanting angle and are considerably broken up.

Thus the total mean breadth of Gangana Chukki is 424 yards, and of Bar Chukki 494 yards, or an aggregate for both falls combined of 918 yards. It must be borne in mind, however, that this figure represents the mean width at normal flow, which may be considerably exceeded in the flood season ; while, on the other hand, at low water nearly the whole of the crest of both falls is bare rock, except for a few isolated wisps and runnels, the volume, as a matter of fact, being then so slight as not to exceed from 50 to 200 cusecs. Indeed, at the height of the dries from February till about the end of June, and owing, besides, to the quantity of water that is regulated for power and hot weather supply, hardly any water passes over the falls at all. The *mean* annual flow is some 5000 cusecs less than that of the Victoria Falls, namely, 33,000 cusecs. But it is during its flood season thanks, as in the case of Gersoppa, to the enormous rainfall of the monsoons, that the Cauvery Falls, for height, breadth and volume combined, take a very high place among the giant falls of the world, their discharge in some years far surpassing that of any other falls, with the exceptions only of Guayra and the Khon Cataracts.

In 1924, for instance, a record flow attained to no less than 667,470 cusecs, an amount a great deal in excess of three times the mean of Niagara, and plunging down, of course, over a far greater height. This figure was no doubt exceptional, but according to Murray's *Handbook for Madras* the ordinary maximum discharge at Bannur, some distance above the falls, is 239,000 cusecs, while at the head of the river's delta the *Imperial Gazetteer of India* gives it as being 313,000. Reclus' figure, by the way, is 469,685 cusecs for the flood flow.

A comparison of the two views of a section of the Gangana Chukki Falls, taken at low water and high flood respectively, will give the reader an idea of the immense difference the falls present at their various stages, and of the tremendous volume at the latter period when the huge masses of rock are entirely submerged.

The Island of Sivasamudram, also known as Hegura, is approximately three miles in length by from a quarter to over a mile in width. Francis Buchanan, M.D., in his book, *A Journey from Madras through the Countries of Mysore, Canara and Malabar*, etc., published in 1807, remarks of this island :

" It would be a fine situation for a village, were it not possessed by a Muni ; on which account, and owing to the terrible disasters attributed to this demon's wrath, no Hindu will settle in the place. The people of Satteagala, at the time of cultivation, carry over their cattle, and sleep with them in one of the old temples, which is a defence against the tigers that are said to be very numerous. . . . The only persons who defy this devil, and the tigers, are two Mussulman hermits that dwell at Gangana Chukki. The hermitage is a hut open all round, placed opposite to the tomb of Pirca Wullay, an ancient saint, and surrounded by some neat smooth areas, and a number of flowering and aromatic trees introduced from the neighbouring forests. One of these hermits was absent on business ; the other had no defence from the tigers but his confidence in the holiness of the place, and in his own sanctity, of which he seemed to have a very favourable opinion."

[illegible]

PART OF THE GANGANA CHUKKI SECTION OF THE FALLS ON THE CAUVERY

Above. At low water. *Below.* In flood.

He goes on to relate the story of Nandi Raja, the son of Ganga Raja who reigned over the neighbouring city of that name, and who is said to have met with many miraculous adventures. He at length "was defiled by eating unknowingly, with a certain servant of the Whallia caste, who had the power of rendering himself invisible, and who, while in this state, partook of his master's food. On this occasion, the Prince consulted the Brahmins, who advised him to put himself to death. He accordingly delivered the kingdom to his son, and, having persuaded his wife to accompany him, they blindfolded a horse, and, having mounted him, precipitated themselves into the Cataract at Gangana Chukki."

Buchanan, who had not, however, seen Gersoppa, states that he had never seen any cataract that could be compared with this for grandeur.

Ancient stone bridges of native workmanship connect Sivasamudram with the mainland both on the Mysore and the Coimbatore side. The former one is variously stated to be from 1000 to 1580 feet long and 13 feet wide. According to *Murray's Handbook*, it is supported on 400 pillars of granite which average 20 feet in height, and at either end there are sculptured elephants raised up on pedestals. Many of these pillars were originally taken from different ancient temples in the neighbourhood and have been chiselled into a variety of forms. On the upstream side of the Mysore bridge there has been constructed the curved regulator whence the channel now leads off to the penstock chamber for diverting the water for power. There is another similar regulator by the bridge leading to the Coimbatore side, by which the whole water of the stream can, if necessary, be diverted into the western channel.

Having fallen into decay, these bridges were rebuilt in 1825 by a certain Rama Mudeliar, a confidential servant of the then Resident of Mysore, who also repaired the various temples and erected a Traveller's Bungalow. The work, which is said to have taken three years to complete, cost several thousand pounds. Lewin Bowring, a former Chief Commissioner of Mysore and Coorg, states in his *Eastern Experiences* (1873) that for accomplishing this work Rama Mudeliar received from the British Government the title of "Janopakár Kám Kartá," meaning "The Constructor of a work useful to the people," and also an estate of five villages yielding £800 yearly; while from the Mysore State he was presented with seven villages yielding £900 yearly. The bridges have admirably withstood the floods, though the water has been known to rise to the extent of three feet and more above them.

As in the case of Gersoppa, the bed of the river in the neighbourhood of the falls is of solid rock, and is extremely rugged and broken up by immense boulders and potholes, over which the waters dash roaring in clouds of spray for some distance before their great leap. The aspect of the falls varies tremendously, of course, according to the stage of the river; but it is generally agreed that the best time to see them is during the rainy season, both on account of the greater grandeur of the spectacle and the fact that during the dry spell the locality is feverish and unhealthy.

The Cauvery usually begins to rise in June and continues to be high till about the end of October. Mr. Robert H. Elliot, who visited Sivasamudram towards the end of September, thus describes the view of the Gangana Chukki Falls as seen from below the tomb of Pir Golub, or Pir Ghaib—apparently the same Mussulman saint whom Buchanan refers to as Pirca Wullay—whence a steep path leads down to the cataract.

"Glancing upwards," he writes, "the view of the river, as the waters race down their steep stony bed towards the falls amidst numerous projecting rocks, is extremely grand and picturesque. There, at a point just below the spot I was standing on, the water plunged down a nearly precipitous descent, from which it apparently (for the spray prevented one seeing exactly) fell perpendicularly into the pool below, sending up as it did so gossamer veils of spray full of fleeting's faint and ever varying iris hues. This pool is flanked, and probably about 100 yards below the foot of the previously mentioned fall, on the northern side, by a precipice about 250 feet high, down which, in four separate cascades, falls the water of the branch of the river which cuts off the small island of Ettikur."

"On the north side of the precipice," he continues, "next to the great fall of the main river stands a piece of tree-clad rocky ground, apparently about 50 feet higher than the precipice, and this is flanked by a rapid at the top, passing into a cascade lower down, which then held but little water, but which in floods must add much to the beauty of the scene."

Mr. Lewin Bowring, who saw this cataract from the same viewpoint, describes it as rushing precipitately over the face of a tremendous abyss and dashing over vast boulders of rock in a

cloud of foam till it hurled itself into a deep pool below, 300 feet from the summit. "The noise made by the roar of the waters," he writes, "is deafening, and as one's ears are stunned by their loud thunder, so one's sight is blinded by the steam of mist which hides from view the sacred stream, as it rushes furiously forward over great rocks to meet the sister fall below."

He describes the latter, namely, the Bar Chukki Falls, as even finer; as from the point whence he saw them, which was from the foot of a difficult flight of slippery steps leading down to their base, the eye could take in a far greater extent of water; and though of less height and perhaps less imposing than those of Gangana Chukki, he considered them the more lovely of the two.

As the reader will observe from the general view of the Bar Chukki Falls, they are divided up into a great number of separate cascades, of which the main falls pour down at converging angles over a semicircular platform of rock in the centre. This indentation, which has been eaten back into the side of the precipice, is sometimes called the Horseshoe. At its base is a deep pit, whence the waters emerge to rush down a steep slanting channel into the great pool below, where they are joined by the other branches of the falls which descend through the heavily wooded jungle to right and left of them.

At high water the numerous cascades, which are seen on the left-hand side of the photograph, become one single immense fall, but when the river is low they are broken into as many as thirteen and more separate ones. To the right, other falls are seen pouring down over the steeply shelving rocks. So numerous, indeed, are the various channels and falls at comparatively low water that, as Mr. Elliot observes, it is extremely difficult to describe them, and he goes on to say that the general effect here "appears to be that you are looking at falls and cascades proceeding from two different rivers, the one flowing from the south and the other from the west." From the main pool below into which all the branches from the numerous falls converge, the river escapes by a narrow gorge, and, lower down, joins its other branch on which are situated the Gangana Chukki Falls.

The falls have for some time been harnessed, *inter alia*, to supply power to the Kolar Gold Fields some 90 miles distant, and for providing light for the streets and buildings of Mysore and Bangalore. The present amount of diversion is, I believe, about 1000 cusecs, which is but the forerunner of a far greater amount in the future.

Their luxuriant vegetation, contrasting with the purple-hued rocks and the dazzling whiteness of the falling waters, make the Sivasamudram Falls more than ordinarily lovely; and, as has been pointed out, their immense flood discharge makes them, also, at that period, second to none in mass with the exception of the cataracts of Guayra and Khon.

CHAPTER XVII

THE GIANTS OF ASIA: THE GERSOPPA FALLS

IN the same way that the falls on the Cauvery occur on a section of that river which forms the boundary between Mysore and Coimbatore, so those of Gersoppa on the Sharavati River are located at a point where the latter divides Mysore from south-eastern Kanara.

Thanks to the enormous rainfall during the monsoons, Gersoppa, as I have previously mentioned, affords a notable exception to the usual rule that great falls occur only on great rivers, for the total length of the Sharavati from its source near Kavale Durga to the point where it falls into the sea near Honavar is no more than about 112 miles, of which it has traversed less than 70 up to the famous falls. Its immense flood volume, however, will be easily understood when it is recalled that the rainfall along the western Ghats averages 100 inches and attains even to 300 high up among the mountains. A fall of from 15 to 17 inches in a single day is by no means uncommon.

The falls of Gersoppa are always known locally as "The Jog," a Kanarese word meaning "Waterfall." The present village of Gersoppa is about 18 miles downstream from the falls, and in its palmy days was called Kshemapura, or the City of Prosperity. Its chieftainship was often held by women. The last of them, Bhairadevi, was attacked and defeated in the early years of the seventeenth century by Venkatappa Naik, the Chief of Bednur. She is said to have died in 1608. When the Italian traveller, Della Valle, visited Gersoppa in 1623, accompanying a Portuguese Embassy to Venkatappa at Bednur, the city and palace were already in ruins and overgrown by trees. The district was especially famous for its pepper; a fact which led the Portuguese to call the Queen of Gersoppa "Rainha da Pimenta," or the Pepper Queen.

Miss Constance E. Parsons, who has written much, and with authority, on the State of Mysore, says that Gersoppa was at one time the capital of the Saluva rulers, "Jains of the Lunar race, distinguished by the epithet 'medini-misaraganda,' or 'champions over the moustaches of the world.' The family was established," she continues (*vide A Tour in the Mysore State*, 1931), "in 1409 by the Vijayanagar kings, but became independent. . . . Of Gersoppa as it was about 1560 an inscription, still wonderfully clear, declares that 'it shines like the Sri-Pundra (central mark on Sri-Vaishnava foreheads) with glittering towers, lines of merchants' houses, crowds of happy people given to all good works, groups of sages, bands of poets and learned men, and multitudes and multitudes of saints. . . . What city in the world so celebrated as Gersoppa Kshemapura?'" (*Epigraphia Carnatica II*).

From Sagar, 20 miles above the falls, and thence onwards, the approach to them lies through the most magnificent and varied forest growth. Hundreds of orchids and giant creepers bedeck the enormous trunks and branches of the trees, whence innumerable monkeys peer and chatter. There are immense waving bamboos, miles of areca nut palms, huge Goni trees, "capable," as Miss Parsons observes, "of sheltering under their dense foliage a caravan of travellers." The blossoms of the red silk cotton tree and of the Potasha afford a blazing crimson contrast to the golden yellow of the scented Champak and the white Sitadandehu.

The general course of the Sharavati River—a name meaning "Arrow-born," and so called because it flows from the Ambu-Tirtha, fabled to have been formed by a stroke of Rama's arrow—is north-west as far as the falls, but at the latter it turns abruptly west and so continues till it reaches the sea.

Few falls in the world vary so much in volume, and consequently in width and aspect, as do those of Gersoppa. While the low water flow may shrink almost to a mere trickle and be incomparably less than the corresponding minimum flow of the Kaieteur Falls, to which, as I have already said, they come nearest in any general comparison, the high-water volume far exceeds that ever attained by the South American cataract, their height being also greater.

The Kaieteur, as we have seen, has a sheer leap of 741 feet, with a further drop of 81 feet in a sloping cataract below the pool into which the main leap plunges, thus totalling 822 feet in all. The width at the crest will vary from about 40 yards at low water to over 120 in flood; while the mean annual volume has been stated to be 23,400 cusecs.

Gersoppa, on the other hand, has a sheer drop in one leap of 829 feet, the depth of the chasm itself being 960. At low water, when the cataract is divided up into four narrow and separate falls, the total width may be no more than about 17 yards. At ordinary flow, however, the width of the river a little above the falls will be about 500 yards, and at the falls themselves, omitting a mass of rock in the centre, from 267 to 293 yards. The mean annual volume is 5387 cusecs, which may shrink to the trifling amount of 6 cusecs at dead minimum, or be increased at the height of the floods to no less than 120,000—a variation of the astounding proportion of 20,000 to 1, and far eclipsing that of any other known falls, except possibly the Aughrabies Falls on the Orange.

The above figures, as in the case of the Cauvery Falls, were kindly obtained for me by Mr. H. D. Rice from the Chief Engineer of the Mysore Government, who has lately been re-gauging the volumes of many of the rivers in that part of India with a view to their potentialities for power. This enormous flood volume—enormous, that is to say, in proportion to the short length of the river—considerably exceeds half the mean flow of Niagara, and is, of course, due to the immense rainfall in the monsoons.

It will be easily gathered, then, that at the peak of the flood season their volume and great height combined render the Gersoppa Falls, at that particular time, perhaps the most stupendous spectacle of the kind on earth. Indeed, one is tempted to assert that here, in the case of Gersoppa at its maximum flood, we have the answer to the vexed question of which is the greatest waterfall in the world. But, alas, as in the case of the Victoria Falls at high flood, so densely shrouded is the whole chasm and its immediate surroundings in thick mist and spray that it is then quite impossible to see anything of the falls at all.

To quote from an account of the conditions which then prevail by M. J. Walhouse : " At the height of the monsoon the whole forest country is a dripping, weltering wilderness, streamlets and threads of water become torrents, and roads are everywhere blocked up by floods and fallen trees. Movement and business are suspended, and the inhabitants almost as much confined to their homesteads as Arctic dwellers by the polar winter. Then the river, a wide furious flood, unbroken from bank to bank, rolls over the precipice in one tremendous torrent. The force and thunder must be overwhelming and sublime, but nothing can be seen—nothing of the precipice, of the gorge below or the river-bed above ; all are veiled by the enormous mist-clouds which fill the ravine and chasm, and roll in prodigious volumes far up the valley, ascending above the trees and bordering hills, and burying everything in a blank uniform grey."

I do not know whether the experiment has yet been tried, but one wonders if at least a partially successful photographic view might not be obtained by the use of the infra-red filter and plates, as has been done in the case of "Mosi-oa-tunya." Be that as it may, all existing photographs, like that here reproduced, show the falls at low or comparatively low water only. They depict them divided up, as they are at that period, into the four separate cascades of the Raja, the Roarer, the Rocket and La Dame Blanche; and to anyone who was ignorant of the enormous increase of water during the monsoons such views do not give the slightest hint of the astounding and awe-inspiring spectacle they would then provide could some magician's wand dispel the surrounding haze.

The only person who, as far as I know, has left any impressions of the falls in at least partial flood is Captain Newbold who visited them in the August of 1845. Though the river had then subsided considerably from its highest volume, he reckoned its flow at about 45,000 cusecs, which, even so, would be far less than half its maximum. He describes how he lay down and peered over the brink of a platform of rock which projected from the edge of the cliff.

"I lay on this shelf," he writes, "and drew myself to its edge, and as I stretched my head over the brink, a sight burst on me which I shall never forget and can never hope to describe. I have since looked down the fuming and sulphurous craters of Etna and Vesuvius, but have never experienced the feelings which overwhelmed me in the first downward gaze into the abyss at Gersoppa. One might gaze forever into that seething chasm where the mighty mass of the Shiravata's waters ceaselessly buries itself in a mist-enshrouded grave."

But if not well seen at such a time, the falls are at least heard. Miss Parsons states that their thunder actually shakes the bungalow distant 300 yards away. Less terrifying, no doubt, but fascinating in their wide variety are the sounds which the falls emit on normal occasions.

Mr. Robert H. Elliot, whom I have already quoted in connection with the Cauvery Falls, has described them as "grand in their totality, grand and melodious in their separate cadences—the deep base of the Raja, sometimes like cannon thundering in the distance, and sometimes like the regular tolling of some vast titanic bell; sounds of the most varied and brilliant music from the Rocket; the jagged note of the Roarer, as its waters rush down their steep, stony trough; the eerie and mysterious sounds which, sometimes like a mingling of startling shrieks and clangs, and sometimes, to the active imagination, like the far-off lamentations o imprisoned spirits (the native idea), occasionally rise from the semi-cavernous cavern which has been hollowed out behind the great pool beneath the cliff; the gentle murmuring note of the White Lady Fall, tangled threads of sound from which fall in fretful cadences on the ear as the wind rises and falls athwart the falls; and lastly, but by no means leastly, the undulating and endless varieties of sounds which, having broken away from their original source, are ever wandering and echoing around the rock-bound gorge."

When the water has sufficiently subsided after the monsoons are over, the Sharavati can be crossed above the falls both by ferry about 2 miles upstream, and, nearer the precipice, by light bamboo bridges which are thrown every year at the close of the rainy season across each of the rapids that feed the four different falls. The width of the river at the ferry is about 250 yards. It is crossed by a raft of bamboos laid across dug-out canoes, the whole being propelled by a long pole. Bamboo piers laid down either steeply sloping bank afford the means whereby passengers can both board the raft and disembark from it.

Mr. Elliot's account of his crossing the river by the bridges conveys a good idea of what the width and volume of the torrent must be in the flood season. At that time, i.e. during the low water period, "the river above the falls," he writes, "shrinks back as it were into a long deep pool which lies at a distance of several hundred yards from the brink of the precipice, and from this pool the water of the river then escapes by four distinct rapids which have cut their way to the brink of the precipice, and fall over the cliff in four distinct falls, each one of widely different character from the other."

After crossing the first bridge, namely' that over the channel which feeds the Raja Fall, he proceeds: "You sometimes walk through, and sometimes clamber over the vast assemblage of rocks and huge boulders which form the bed of the river, and are deeply submerged when the river is full. The sight here is extremely curious and interesting, as, after leaving the bridge of the Raja rapid, there are about 1000 feet of rock and boulders to pass through or over before you reach the next rapid, and, when halfway, there would be nothing to show that you were not wandering through a mere wilderness of rocks were it not for the unceasing thunder, far below, from the bottom of the Raja Fall."

Again, after crossing the bridge over the next rapid, that of the

Roarer, he states there is a further 700 feet of similar river-bed to be traversed to that of the Rocket; and, after crossing the third bridge over the Rocket rapid, yet another 500 feet of river-bed to the fourth bridge across the Dame Blanche rapid. Thus, without reckoning the widths of the various rapids themselves, he had to traverse, in all, 2200 feet, or 733 yards of dry river-bed from one bank to the other.

He concludes: "I have met with no estimate of the total width of the fall when the river is in high flood, but it can hardly be less than half a mile wide, and the depth of the water, as one can see from the high water mark, must be very great. It is interesting to note on the tops of the boulders here and there the circular stones that have, during each monsoon, been whirling round and round, each one in its own pothole."

The distances given by Mr. Elliot, as will be noted, are a good deal in excess of the figure I have above quoted from the Chief Engineer of the Mysore Government, and possibly involved a certain amount of circuitous ambulation. They will serve, however, to impress on the reader's mind what the width and volume of the Sharavati must be at high flood.

The river usually begins to rise in June, and continues more or less in a flooded state till December when it becomes sufficiently low to be safely crossed by the ferry as above described. But the volume continues to be considerable till early in March. It is from June to early December that the falls are, generally speaking, invisible on account of the spray and mist.

The contour of the edge of the precipice over which the stream leaps has been compared to that of a hook with a straight handle, the hook being on the Kanara side of the channel, that is to say towards the right bank, and the straight handle towards the left or Mysore bank. The first fall on the right side, namely, the Raja, and, as well, that of the Roarer to the left of it, are both situated in the hook and nearly opposite each other; while the Rocket and La Dame Blanche pour over the straight handle. All of them fall from the same level and drop approximately 830 feet, but they vary greatly one from another in appearance and formation.

The crest of the Raja Fall is deeply cut back into the right side of the hook, where in the course of ages the river has eaten out the softer micaceous schists and talcose from the harder gneiss of which its bed is composed. This fall, which usually carries the greatest volume of the four, was so named after a chief of the Bilgi,

[illegible]

who at one time intended to erect a small shrine at the top of the cliff hard by. It is sometimes also called the Horseshoe Fall, as well as the Main and Grand Fall. It plunges into the abyss in a single sheer leap, shooting well out from the cliff into the pool below, which here has a depth of 132 feet. The *Gazetteer of the Bombay Presidency* states that the Raja had then (1883) held its present position for about forty years, but that in 1845 one of the crags at the edge of the cliff gave way, and, as it fell, carried with it an outstanding ledge of rock "laying bare the face of the scarp with a noise that startled the country for miles."

The second fall, known as the Roarer on account of its noise and fury, takes its leap in two descents. It first precipitates itself into a large hollow like a cup a little below the edge of the cliff, whence issuing it surges down a steep rocky trough at an angle of about 45 degrees, from the extremity of which it shoots out to mingle itself in mid-air with the descending column of the Raja, both falls then plunging together into the basin below. "This fall," writes Gordon S. Forbes, "reminds one of a mad giant escaped from Bedlam. He has torn and ground the face of the rock in his downward course and is for ever frantically striving to shatter it further."

The third fall, the Rocket, is generally regarded as the most beautiful of the four. After falling from 100 to 150 feet it strikes a projecting rock, and for the remainder of the 700 feet of its descent comes down in what has been described as "a rocket-like curve." In the words of M. Combal, who visited the falls in 1880, "a regular semicircle of darts resembling rockets are thrown right out for, apparently, 40 to 50 feet. These gradually melt into the great body of spray." Others have compared its brilliant jets of spray to falling stars and meteors.

Lastly, and in contrast to the foam and fury of the other falls, comes the fourth fall, the graceful La Dame Blanche, also sometimes called La Reine or the Rani, "an Undine-like cascade," as one writer has described it, "gliding quietly over the mountain side in a sheet of foam"; or, as another has happily said, "like folds of silver gauze shaken by giant hands."

The width of the chasm below the falls is about 650 yards, it being reckoned to be 700 yards from the Bombay bungalow on the Kanara bank to the bungalow on the Mysore side. Miss Parsons gives the information that rooms can be obtained by visitors in either of the above by applying, in the former case, to the Executive Engineer, Karwar, North Kanara, and, in the latter, to the District Forest Officer at Sagar. It is from the Mysore side that the best views can be obtained.

The descent to the foot of the cataract is by a very steep and winding path which, later, develops into a flight of rude and uneven steps formed by stones placed between the rocks. In making it, one is drenched with spray when the wind blows in that direction from the falls, but the new views from below amply repay a wetting. Here, as in the case of the bottom of the great amphitheatre at Kaieteur, the ground is strewn with enormous rocks and boulders which have fallen from the cliffs during the ages that the river has been eroding them. Through and over these, which seem to threaten to choke its channel, the river foams and roars in its maddened haste towards the western sea, and at one point, some 400 yards below the falls, it disappears for, it is said, about 150 feet under a natural bridge of rock which here spans it from the Kanara to the Mysore side, and the summit of which is said to be always above water even in the greatest floods. Miss Parsons says that here below the rainbows are even more wonderful than as seen from above. " Indeed, it is quite possible," she writes, " to find oneself in the very centre of a perfect arc, and to see one's companions drenched in radiance, similarly halo'd."

It is, indeed, the wonderful and varied colour that invests the falls and their surroundings, changing ever from dawn to eve, that is one of the outstanding glories of Gersoppa. Mr. Elliot speaks of it as " constantly, though gradually shifting and altering, for as the sun declines the rainbow hues move steadily upwards on the face of the falls, and the colours of the rocks, which are of varying shades of purple and yellow, continually alter in character with the sinking day."

So, too, Miss Parsons describes the beauty of the cataract by moonlight as " almost unbearable ; especially when pale lunar rainbows add their frail splendour, their elusive fairy gleams." When to these effects are added the beauty and variety of the luxuriant foliage of the forest, the flights at morning and evening of parrots, golden orioles and other brilliantly plumaged birds, and, as well, at certain seasons of the year, the clouds of gorgeous butterflies, it may well be doubted whether any other of the great falls, except possibly those of Iguazu, can rival Gersoppa in the loveliness of their setting.

Here also, as in the case of Kaieteur, innumerable swallows, and rock pigeons as well, flit in and out of the spray mists ; while there is an added resemblance in the great hidden cave behind the plunging column of the Raja Fall which may be compared with that which is curtained by the South American wonder. The mention of this deep cavern behind the Raja, by the way, reminds me that it was entered, for the first and last time as far as I am aware, on the occasion when the falls were first measured in March, 1856. A view of this cave will be seen in the photograph which was taken when the falls were at very low water. An account of the feat will be found in the *Gazetteer of the Bombay Presidency* and is of sufficient interest to be quoted here. The original was formerly kept in one of the bungalows adjoining the falls, but appears to have been removed or destroyed.

The persons who were deputed by the Government to undertake the task consisted of two officers of the Indian Navy, Messrs. Taylor and Williams, and Mr. R. S. Grey, of the Sixteenth Regiment M.N.I. Their account of the proceedings reads as follows :

"We threw a light flying bridge across the chasm from the tree overhanging the Roarer to the rock westward of that called the Raja's rock. To this we slung a cradle of light bamboo, capable of holding two people comfortably. The cradle was braced on one single and two double blocks, through which we rove the four hawsers composing the bridge. We had previously placed the bridge from the Raja's rock to the tree ; but we found that the lead line would not, from any single part of the bridge, plumb clear of the Roarer, or of the rocks on either side ; thus proving beyond a doubt that the pool had never been plumbed from the sides of the chasm.

"In the forenoon of the 12th of March, all arrangements being completed and provision made against remote contingencies, we made the passage in the cradle from side to side, halting in the centre to pour a libation to the guardian spirits of the chasm. The arrangements being found perfectly satisfactory, we proceeded to plumb the pool. The cradle with one person was eased away to a distance of 47 feet from the tree. The lead line was lowered from the shore through a block or pulley on the cradle, passing down through its centre. The plummet consisted of 7 lbs. of lead placed in the centre of an annular life-buoy slung horizontally, the whole weight being about 18 lbs. When the lead reached the pool the life-buoy floated it, and thus the lead man in the cradle felt the loss of weight.

"Having during our service had a little experience in deep water, we knew that a loss of 20 lbs. from a plumb line of upwards of 100 fathoms would be scarcely appreciable, and so we found it But by hauling up half a fathom and letting go suddenly, the lifebuoy made a discernible splash in the water. A mark was then placed on the line close to the block, and the angle of its dip taken with a theodolite on the brink of the precipice near the tree, at the hypotenusal distance of 47 feet. This gave the perpendicular depression of the cradle below the instrument (on a level with the tree) as 14 feet ; which, added to the line paid out, 815 feet, gave the exact depth 829 feet.

"In the afternoon we descended the ravine, and with a raft of a few bamboos and three boat's breakers, paddled and sounded all round and across the pool, having previously, from above, turned off a great part of the Roarer into the Rocket. We found that 22 fathoms or 132 feet was the greatest depth. This sounding was taken very near the west side, about 30 yards from the head of the pool or base of the Grand Fall. We climbed the rock on which the Roarer falls, and when about 30 feet up it, the stream, which before had been rather mild, came down with such force on our devoted heads that we had to 'hold on by our eyelids' to prevent being washed off. . . .

"On the 15th of March we broke up our bridge, from which we had taken several satisfactory views of the chasm, and descended by a rope into the cup of the Roarer, where we breakfasted, and afterwards with some little difficulty at one point, passed down by the side of the Roarer, and reached a position at the back of the Grand Fall, whence the Rocket and the Roarer were seen to the right. From this place alone can a correct idea be formed of the great depth of the cavern in front of which the Grand Fall drops. The sky clouded over and thunder pealed when we were below. The effect was extremely grand. At 5 p.m. we reached the top of the cliff in safety."

In such wise was Gersoppa measured nearly eighty years ago. One wonders for how much longer its changeful beauty will be left to awe and inspire any who are fortunate enough to visit it. I have been told that it is already ear-marked for exploitation in the interests of cheap power, which will assuredly mean that except at high water the falls will cease to exist.

CHAPTER XVIII

SOME FURTHER NOTABLE INDIAN WATERFALLS

AMONG other waterfalls in India whose great volume during the monsoons makes them remarkable are those of Gokak, on the Gatparba, or Ghatprabha, River in the Belgaum District of Bombay between 3 and 4 miles north-west of Gokak town. The Gatparba, like the Sharavati, is not much over 100 miles in length and drains an area of about 2000 square miles. It is one of the tributaries of the Krishna. It rises in the Western Ghats south of the Amboli Pass and at the point where it takes its leap over a sandstone cliff in the Gokak Gorge has traversed a little over 80 miles.

Like the Sharavati, the variation of its volume is immense; the low-water flow sinking in January to as little as 170 cusecs, but sometimes attaining to well over 100,000 cusecs in flood. In an exceptional flood which occurred in July, 1882, the discharge at the falls was reckoned to be 135,700 cusecs, with a depth of water at the crest of 20 feet, while during a still greater flood in 1822 it was even more.

The falls, which are horseshoe-shaped, have sometimes been compared to a narrower edition of Niagara and especially as regards the formidable rapids above them. The slope of the latter increases as the river nears the brink of the precipice, causing the waters to shoot out with tremendous impetus and to send up clouds of spray from the deep pool below, which sometimes rise up for hundreds of feet above the crest of the fall, blotting out any good view of it from a spectator stationed beneath it.

These upper rapids, indeed, in the opinion of Captain Newbold, whom I have already quoted in connection with Gersoppa, are almost a finer sight than the falls themselves. To anyone looking up towards them from near the edge of the fall, he says that the monster waves seem to "fill the view to the sky line, raging in wild tumult, and, against the mighty rocks, dashing in lofty columns of spray with a roar which deadens the deep bass of the falls."

The height of the latter at ordinary flow is about 176 feet, but it is said that the greatest height of the cliff over which flood water is sometimes hurled may be 200 feet. The upper rapids commence from a pool in the river about 2000 feet above the fall and descend 43 feet, and the cliffs on either side of the fall rise up about 100 feet above its crest. At low water the falls are divided into two channels no more than 40 and 50 feet in width respectively, but in times of flood the river a little distance above its leap may be from 300 to 500 yards wide, contracting to 80 yards at the edge of the precipice ; though another account puts the width of the crest in the floods at about 193 yards. In flood time the whole fall forms an immense and dense column of a thick reddish-brown colour, which, in the words of Captain Newbold, " plunged heavily down, with a deep thundering sound."

" This ponderous descent," he continues, " and the heavy muddy colour of the water conveys a feeling of weight through the eye to the senses, which is relieved by the brightness and airiness of thin clouds of white vapour and amber-coloured spray which ascends from the basin at the bottom of the gorge in curling wreaths, curtailing the lower portions of the fall, and through which the basin was only seen at intervals when its surface was swept by the fitful gusts that swept up the glen."

But when in a lower state, the river forms two or three separate falls, one of which makes an unbroken descent while another is partly broken about half-way down. Additional small shoots of water may then also be seen gushing out in jets from clefts high up in the cliffs. The amber colour of the river when swollen is much like that of the Potaro in the case of the Kaieteur Falls, but a more interesting resemblance to the latter may also be noted here, namely, the occurrence of fissures in the river-bed above the falls, through which, as Sir Everard im Thurn thought to be the case at Kaieteur, a good deal of the water escapes instead of passing over the fall.

At the sides of the pool below, which has a breadth of 200 yards and is from 40 to over 60 feet deep, according to the state of the river, lie huge masses of rock which have fallen from the cliffs above, having been carried away by the force of the water.

In former times, and possibly also to-day, this pool was the haunt of numbers of enormous crocodiles, and the natives who had a great superstitious awe of the place used to believe that demons inhabited a temple deep down beneath its surface. They also ascribed the wearing of the rock, caused by the eroding force of the water above the falls, to the Pandav brothers, and numbers of them were wont to worship in the ancient ruined temple of Mahalingeshvar dedicated to Siva by the right bank of the river, and to bathe in the numerous pot-holes which are there to be found in the river-bed, some of which are 8 feet wide by as much as 6 in depth. The falls appear to be receding rapidly and it may be no long time, geologically speaking, before the rapids above them will disappear owing to the levelling down of the river-bed.

A writer in *Murray's Handbook for Madras* has described a ledge by passing along which it is possible to get behind the fall at normal times when the water is not too high and when there is no wind, but, as he also says, it is rather a hazardous journey and the ledge in places is so narrow and slippery that most of it has to be negotiated crawling, and sometimes even sitting and lying. "The awful din, the frightful upward blasts of icy wind, the deluges of water, the seething roaring waves below, the blinding spray, the darkness, and the knowledge that a slip is sure and sudden death combine to make the passage a terrifying ordeal."

The falls are said to display their greatest beauty when the water is comparatively low and therefore more clear. At such times the spray rockets are dazzlingly white, and the pool is "a lovely green warmed by a brownish tint caught from the rich reddish hue of the high wall-like cliffs that rise a hundred feet above the crest of the fall."

To-day there is a fine suspension bridge across the river above the falls, and their romantic appearance has not been improved by the erection of cotton mills on the right bank which are worked by turbines supplied with power from the cataract.

Higher and yet more lovely are the falls on the Yena, another tributary of the Krishna, near Satara in the Poona division of the Bombay Presidency, though they do not, probably, ever attain to so great a volume as those of Gokak. The drop here is said to be 500 feet in a sheer descent which is unbroken when the river is high, but at other times it is broken up by projecting rocks about a third of the way down. The latter cause the plunging torrent to scatter into numerous streaks and spray-jets irradiated with the glint and sparkle of gorgeous rainbows in the sunlight, and affording a vivid contrast to the black sides of the chasm into which the river pours.

Turning towards the eastern side of the Peninsula, the most notable waterfalls are to be found on the southern Tons River and its tributaries. The latter rises in Maihar State, its source being generally supposed to be located in the Tamasa Kund, a tank on the Kaimur Hills about 2000 feet above sea-level. It enters the United Province at Deora in Allahabad District and finally flows into the Ganges 19 miles below the junction of the latter with the Jumna after a course which is stated to be about 165 miles.

The falls, which are three in number, occur not far from Rewah and are occasioned by the descent of the waters over the rugged escarpment of the Vindhyas. One of them is on the Tons River itself, while the two others are on two of its tributaries, namely, the Bihar and the Chachaia. Some account of them accompanied by an illustration is to be found in *A History of the Boondelas*, by Captain W. R. Pogson, of the Bengal Army, published in 1828, who, in turn, derived his information from an officer who was serving in Rewah in the campaign of 1813 and who had frequent opportunities of visiting them.

The latter describes the fall on the Bihar as being the highest and finest of the three, and gives its vertical drop as measured by a line "held above and below" as being 371 feet, with a flood width at the crest of 641 feet. He states the height of the fall on the Chachaia, or Chichyea as he terms it, to be 301 feet with a rapid above it descending a further 100 feet, thus making the total drop over 400 feet. This rapid, as in the case of that above the falls of Gokak, causes the water to shoot out with great force over the edge of the cliff, thus adding to the grandeur of the spectacle. The basin into which these falls plunge he states to be 800 feet across and 130 feet in depth.

"The rainy season," he writes, "is most eligible for viewing them. The verdure of the grass is there, too brilliant to appear natural on canvas. Every tree affords a fragrant blossom, every plant a flower, yet the eye is so fascinated by the awful grandeur of the fall, that it is long ere it rests on the softer beauties of the landscape. When the sun shines through the spray below, the prismatic colours in their most vivid tints form (if a misnomer be allowed) an extensive rainbow. . . . Each rock is encircled with the wild vine, bearing a profusion of black grapes. Lilies, resembling those of the valley, spring up in abundance, and among a variety of flowering shrubs the superba gloriosa is conspicuous."

He gives no detailed account of the Bihar or Tons Falls, and indeed as regards the latter states that descriptions of it addressed to the editors of certain Calcutta papers were declined, as they were considered to be incredibly exaggerated. Captain Pogson himself, however, adds a note stating that he heard from a friend that the height of the Tons Falls, according to three separate measurements, was agreed as being 220 feet, with a breadth at the height of the rains of 500. As in the case of Gokak, the cliffs on either side above the falls rise about 100 feet, while the gorge below them is from 200 to 300 feet deep and 200 yards across.

I have not been able to find any statistics as regards the volumes of these falls. The officer whose account I have quoted says that he was encamped about 8½ miles from the Tons Falls and about 10½ from those of Bihar, and that the spray-clouds of both were frequently visible, and also that the roar of the Tons Cataract could be heard when the wind was favourable.

The Chachaia Falls appear to be about 30 miles distant from the same point, and were the nearest of the three to the Ghats. All three descend from high, abrupt precipices and afford evidence of having receded very considerably. Like most of the Indian rivers the flood discharge is very considerable. The *Imperial Gazetteer of India* states that the Tons will rise at that period 25 feet in a few hours, and that the highest recorded rise has been as much as 65 feet. Another, and the principal tributary of the latter, the Belan, also boasts a waterfall of some 100 feet in height.

Before turning to the north of India, the falls on the Nerbudda, some 11 miles from Jubbulpore, should be mentioned on account of the beauty of their surroundings, though they are only about 30 feet in height. This great river, which has a width of 600 yards at Jubbulpore, is here pent up in a wonderful marble gorge into a channel which, in places, is no more than 20 yards broad. The late Sir Richard Temple writes:

"The Nerbudda, becoming pent-up among magnificent limestone rocks, slings itself tumultuously over a ledge with a fall of some 30 feet, called the Dhurander (the 'misty shoot') and then enters on a deeply cut channel, literally cut through a mass of marble and basalt for nearly 2 miles. The river, which above this point has a breadth of 100 yards, is here compressed into 20 yards. At the channel below the surface of the surrounding country, the river passes through a double row of marble bluffs, or even between a wall of marble on either side. These glittering white steps are from 50 to 80 feet high. This is the place known as the Marble Rocks."

The loveliness of the blue pellucid waters in contrast with the glittering purity of the marble walls on either side has justly made this spot famous. According to Captain J. Forsyth, however, in his book, *The Highlands of Central India*, visitors to "the Fall of Smoke" have to be on their guard against attacks by certain venomous colonies of bees which have their nests among the jutting ledges of the cliffs, and appear to be particularly spiteful during the hot weather.

Captain Forsyth records an occasion when, disturbed by the shooting of rock pigeons, these bees attacked an engineer and his friend who were taking soundings of the river from a boat in view of a projected crossing of a railway. They were obliged to jump overboard to escape the insects, with the result that the engineer was carried downstream and drowned, while his companion only saved himself by constant long dives under the water and by hiding in a cleft in the rock.

Among the waterfalls of note in northern India there is an account of one of remarkable height in Frederic Drew's *The Northern Barrier of India*, 1877. I have not, however, come across any other description of this fall.

It is situated on a tributary of the Chinab, one of the chief rivers of the Punjab, and near the town of Kishtwar, in Kashmir.

" One conspicuous and beautiful feature," he writes, " is made by a waterfall of great height, which comes over the cliff on the opposite side of the river. Of this fall it is impossible to obtain a near and at the same time general view, but by going some way down the slope we get a fair sight of it, though at the distance of a mile or more. The water comes down not in one but many jumps ; the aggregate height of the falls within view is about 2500 feet, and above these are a few hundred feet more, which can be seen from other points. The first two falls are each of about 500 feet ; these are conspicuous from the town ; below them are two or three smaller ones, making up 600 or 700 feet more ; then there are irregular drops and cascades, partly hidden by vegetation and by the irregularities of the channel, these extending for some 800 feet to the river ; thus the 2500 feet are made up.

" In this waterfall there is every variety of movement. In the greater leaps the water—though in volume not little, for the roar is distinctly heard at a distance of 2 miles—becomes scattered into spray ; again it collects and comes over the next ledge in a thick stream ; in parts it divides into various lines, which, at the distance seem vertical, immovable white threads. In the morning sun the spray made in the greater leaps shows prismatic colours, visible even at the distance of our chosen point—a phenomenon attributed by the people of the place to fairies who bathe in and display the strange hues of their bodies through the shower."

Captain C. M. Enriquez, on his trip to Kashmir, described in his book, *The Realm of the Gods*, does not mention this fall at all though he passed through Kishtwar. In a more northern part of the country, however, he refers to " the splendid cataract " of

Arabal, or Ahribal, which occurs on the Veshu River, a stream which issues from the "dark-green" mountain tarn of Konsa Mag in the Panjal Range. The fall itself, apparently, is only 40 feet in height, but of considerable volume early in the year. He relates that the precipices above the fall, which rise up for 500 feet, have the sinister reputation of being a favourite place for suicides among the Hindoos, who cast themselves from the summits into the boiling whirlpool of the fall below. It is interesting to note that the Veshu River issues from the tarn, not from its surface, but through three tunnels in the rocky barrier which confines the lake, and about 500 feet below its level.

It is probable that in Kashmir and, as well, all along the southern slopes of the mighty Himalayas, there are numerous waterfalls, many of which, perhaps, may rival in height even those in the Yosemite Valley or on the precipices of Roraima, but apparently very few of them have been described nor are their names known.

Before leaving India, however, we may note a few falls in the Nilgiris and in Ceylon, though none of them have any great volume. Of the former the Kolakumbay Falls are said to be the highest with a sheer drop of 400 feet; but the best known are probably the Upper and Lower Falls on the Pykara River the name given to the upper course of the Moyar. The two leaps by which it descends from the plateau to the lower country are 180 and 200 feet respectively, that of the latter, which is the Lower Fall, being the finer. They are situated not far from Naduvattam in the north-west angle of the plateau. The width of the river in the dry season is about 40 yards, and in the neighbourhood of the falls it flows through, or over, a succession of deep holes divided by shallows. The Kulhutti Falls which are fed from the surplus water of the Ootacamund Lake, have a drop of 170 feet, and the Kartairy Falls, 180 feet. The latter have been harnessed since 1904 to supply power for a cordite factory. Lastly the St. Catherine's Falls at Kotagiri descend 250 feet.

In the magical Island of Ceylon the falls that are generally considered to be the finest are those in the glen of Ramboda, or Rambodde, near Nuwara Eliya. They descend on either side of the defile from the Puna-Ella and the Garunda-Ella, both tributaries of the Mahawelli-ganga, which they join in the valley below. Both are imposing after the rains, but, as in the case of most other waterfalls in Ceylon, it is their gorgeous tropical surroundings rather than any great volume which makes them noteworthy. Other falls are those of St. Clair on the Kotmale River in the Dimbula district, which have a step-like formation, and, not far above them, the Devon Falls, which plunge down into a deep ravine.

Captain Enriquez in his book, *In Ceylon Past and Present*, singles out the Diyaluma Falls, near Koslanda, as one of the sights of Ceylon, a name which he tells us may be given the meaning of "Falling Mists." They drop over a black precipice 570 feet in height, and he describes them as "so awe-inspiring that it is hard to take one's eyes from them."

"First," he continues, "it descends in a sheer cataract until broken half-way down by a shoulder of rock that rises agressively to meet it. In this encounter the water is smashed into spray, so that it completes its descent in eddies of mist that are blown this way and that by the breeze. . . . But if it should be so far blown out of its course as to miss the half-way buttress, then the water falls the whole 570 feet like a column of smoke that is dashed to pieces on the rocks below."

Turning from Ceylon to Annam, we may note the Chutes du Lien Khanh and the beautiful Chute Pongour, where the water in places cascades down over an immense natural stairway of rock. Both these falls are in the neighbourhood of Dalat.

CHAPTER XIX

SOME FURTHER WATERFALLS OF ASIA AND OF JAPAN

AS regards the rest of Asia, one would expect to find many fine waterfalls among the various great mountain ranges that rear themselves aloft in succession north of the Himalayas, but one finds but scanty mention of any of them in the somewhat infrequent books of travel in those regions, which are still to a great extent unexplored in any detail.

A writer who has described quite a number, however, is T. Witlam Atkinson in his *Travels in the Regions of the Upper and Lower Amoor*, etc., published in 1860, as well as in a previous work, *Oriental and Western Siberia*, published in 1858. In both these books he gives many reproductions of charming water-colour sketches that he made of some of these falls; and these, combined with his descriptions, conjure up at times visions of some enchanted kingdom of which the Jinns were, surely, the architects. Thus, in describing the rocks that formed the setting of a fall which plunged into Lake Altin-Kool in the Altai Mountains, he speaks of them as being "of every variety of colour some bright red, others purple, yellow and green. I found several beautiful specimens of marble: one a white with purple spots; another, white with bluish-purple veins. These had been washed down from the mountains above. There were masses of a deep plum-coloured jasper, also tumbled down from their beds by the torrent."

Another fall he mentions pours into the same lake from three separate streams which unite at the top of a tremendous precipice and then plunge down over a deep circular recess in a succession of falls, at length rushing out through a natural arch and falling into the lake. He estimated the total height of these falls at not less than 2000 feet.

Here, again, is an account of another fall which he came across while traversing a 1200-foot-deep gorge in the mountains:

"Presently we caught a glimpse of white vapour, and in a few minutes stood before a sheet of falling water that came bounding from a rocky ledge 300 feet above us. It fell into a deep basin, out of which it came seething as from a cauldron. Looking upwards the scene was sublime: three successive falls were visible, leaping from rock to rock, and flinging their white spray into mid-air. The precipices have been worn by water into pillars and columns, and round them the spray and vapour were curling in wreaths as the wind wafted them upward. In front of the middle fall stands an enormous mass of black rock, quite isolated and from 60 to 70 feet in height. The falling water strikes upon the head of this, and is thrown off in innumerable jets, forming a crystalline crown for the stony monarch of the chasm; while thin sheets of water descended over his sides, clothing him with a liquid garment through which his gigantic form was indistinctly visible. From behind this mass a cloud of vapour rises, that covers the rugged crags above as with a veil, gently wafted up by the breeze. Still higher there were other falls, but invisible to us."

And, again, of a further fine fall in the Ala-tau Mountains, at the top of which he found blocks of the finest green and purple jasper, he writes:

"We were standing upon a mass of red porphyry that rose perpendicularly from the bottom of the gorge, not less than 800 feet. The opposite side was equally abrupt, and the width of the chasm about 400 yards. . . . The falls were before us in their full grandeur, at about 600 yards distance. The water bounds over a ledge of rocks formed into a crescent, down which it leaps in one broad sheet for about 600 feet. Then it was seen dashing and foaming over fallen rocks for about another 150 feet, whence there was a second fall of 350 feet; after which the water rushes down the ravine for about 100 yards, and then leaps over a third fall, apparently higher than the second. From the bottom of this it tumbles and boils, appearing like snow among the dark masses beneath, and then the torrent rolls on down the gorge. At some distance beyond the top of the fall, high precipices and crags rose up, and over these were seen the snowy crests of the chain."

One of the highest and most beautiful of the falls he came across was one which he says was known as the Ghilder-a-gar-a-ghi in the Actou Mountains. Here the upper leap is a sheer 800 feet, the fall reaching the bottom in vapour. When standing beneath it, Atkinson says that it appeared stupendous, and the roar so great that the voices of the Cossacks who accompanied him could not be heard. As in the case of one of the falls mentioned above, a natural arch of rock spans the torrent a little distance below, after which the stream again descends in fall after fall till it reaches the plateau 5000 feet lower down, and within a distance of about two versts, or approximately 2340 yards.[1]

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[1] A verst is 1170⅓ yards, that is, 3 versts would be equivalent to 2 miles less 9 yards.

The volumes of some of these falls would also appear to be considerable at certain seasons, for he mentions another that descended into a gorge which in places narrowed to 22 yards, where the marks of the flood water showed a rise of 35 feet. Near some falls on the River Kopal he found a warm spring which rose in a ravine formed of yellow and purple marble, and of striking beauty.

I have not found any of the falls here described mentioned at all by other travellers in these regions since Atkinson's day ; but the country is, of course, even now but little known and seldom visited by Europeans. His accounts, however, are sufficient to indicate that the vast mountain regions of central Asia contain many formidable and beautiful waterfalls, some of which may well rival any others in the world as far as height is concerned.

Almost equally little known, as far as any popular accounts of them are concerned, are the various falls in the Caucasus Mountains. Lieutenant-General Sir Arthur Thurlow Cunynghame in *Travels in the Eastern Caucasus*, etc., mentions a fine fall on the Tabot River in the neighbourhood of Honsak and Bodlith, where the stream hurls itself over a rocky precipice some 300 feet into a gloomy ravine. He relates that it was a little below this fall that the redoubtable Shamyl, a Chief of the Circassian Tartar tribes, who had defied the Russians for thirty years, caused to be thrown over the cliff and drowned the infant Mohammedan Prince of Honsak. I have not found any other description of these falls, which are described as being very beautiful.

Mademoiselle Thérèse Roussel, in her *Souvenirs d'une Française en Arménie*, also alludes to the Chute du Tortoum-Goel on the Tortoum-Sou River which appears to be of considerable volume. Above these falls the river forms a sort of lake over 7 miles in length by two-thirds of a mile wide. No details of the height are given, but she states that in the summer season the falls can furnish 20,000 h.p., and 100,000 h.p. in the winter.

The last of the aqueous leaps which I shall mention on the mainland of Asia is of no great volume, and is, indeed, rather in the nature of a series of cascades than an imposing waterfall ; but on account of its remarkable surroundings and romantic associations the descent of the Nahr-Ibrahim, the ancient river of Adonis, at Afka in Syria decidedly merits being included among the world's notable falls.

The celebrated grotto or cavern in the Lebanon Mountains from which the stream issues, and immediately below which the cascades occur, lies at the base of a precipitous amphitheatre or *cirque*, wilder and grander far even than that which forms the setting for Kaieteur. Here the rocky ramparts rise up for a sheer 2000 feet and more above the grotto's mouth, but sparsely clad with vegetation except for a few pines and enormous juniper trees, which here and there find footing among clusters of knotted oaks.

It is supposed that the water finds its way into this grotto by some hidden channel from the heights above, its volume being markedly increased at the melting of the snows. After the rains its colour assumes a reddish tint, which was fabled by the ancients to be caused by the blood of Adonis who was supposed to have been killed by the boar near this spot. Indeed, the river may sometimes in truth have been dyed by human blood if there is any truth in the story that at certain seasons some of the most beautiful young girls of the district were sacrificed here in connection with the worship of Tammuz or Adonis. It is quite possible, however, that the tale may have been an exaggeration of the early Christians who had little scruple in depicting all so-called Pagan rites in the blackest possible colours.

The great grotto is situated on the eastern side of the amphitheatre and is quadrangular in shape, being nearly 200 feet in width by as much in height. The stream which issues from its depths descends in foaming cascades among vast fallen blocks for a vertical distance of about 180 feet down to a point where it is spanned by an ancient one-arched Roman bridge ; and on the right and left it is joined by two other torrents which go to swell its volume.

Below the bridge there are a succession of three further cascades which pour from one natural basin to another, all so symmetrically cut in the rock as to give the erroneous impression that they must have been hewn out by human agency. It was one or another of these basins that was used by the ancients as a means of consulting the oracle. This was done by casting into the water objects of gold or silver, and sometimes pieces of silk. If the offering was agreeable to the goddess the objects were at once engulfed in token of acceptance, even in cases where they would naturally have floated ; but if not acceptable, they remained floating on the surface.

On the left bank of the stream on a small hillock are the ruins of the temple of Venus Aphaca built by Cinyras, of which but little more than the foundations now remain in the mournful shade of some gigantic walnut trees. Here in the olden days were celebrated the mysteries of Venus and Adonis, or Astarte and Tammuz, and at certain times of the year, notably in midsummer, great crowds gathered to take part in the sacred ceremonies, and especially women who loudly bewailed the latter's untimely death. One recalls the lines of Milton :

> " Thammuz came next behind,
> Whose annual wound in Lebanon allured
> The Syrian damsels to lament his fate
> In amorous ditties all a summer's day ;
> While smooth Adonis from his native rock
> Ran purple to the sea, suppos'd with blood
> Of Thammuz, yearly wounded."

Afka, or Aphaca, was, in short, one of the most famous of those numerous sites of antiquity, so often established near a river or lake, which were dedicated to some deity of Fertility. The exaggerated accounts of the early Christians, however, of the supposed licentious nature of the religious rites here celebrated, persuaded the Emperor Constantine to have the shrine demolished, and the inhabitants of the place were removed to Heliopolis. Even up to comparatively recent years Afka was still regarded as a holy spot by the natives of the region round about, who were at times accustomed to hang up rags on the surrounding trees in place of the ex-voto antiques of other days.

To-day the wild roses, the sweet-scented blossoms of the sorbus trilobata, the scarlet flos Adonis, or blood-drip, emblematic of the wounds of the youthful hunter, and the thuja trees with their purple fruit alone recall the latter's old time worship. Nor is even this famous and charming spot safe from the blight of modern spoliation ; for I have been told that some time ago a scheme was mooted to harness the cascades for power, though I am not aware whether it has actually been carried out.

Before turning to the waterfalls of New Zealand, Australia and the various islands of the Southern Pacific, it will be convenient here to glance at some of the Japanese cascades, which, though in no case of any great volume, include some arresting and lovely examples. I have already referred in my introductory chapter to the beliefs of the old-time Japanese in the tutelar divinities of streams and to their almost Greek-like love of the beauties of nature.

Waterfalls were considered to be especially the haunts and, indeed, the manifestations, of the all-pervading Unseen Spirit, and hard by many of them were erected Shinto temples to which pilgrims from all parts would resort to worship. To visit some noted waterfall, as long as such was not merely in a spirit of idle curiosity, was, as a matter of fact, regarded as an act of reverence and piety by the priests who presided over these sanctuaries.

The mountains of Nikko in eastern Japan are especially prolific of falls. It is said that within a radius of some 15 miles of Nikko itself there are close on thirty different cascades. Perhaps the most noted of these are the falls of Kegon, or Kegon-no-taki, on a stream which issues from Lake Chūzenji at the foot of Mount Nantai-zan. The water here pours over a ridge of lava, which forms a wall confining the lake, and drops a sheer 250 feet into a deep and gloomy pool below, whose forbidding aspect is not relieved by the reflection that this spot is said to be a favourite place for suicides. At times the torrent almost dries up, but after the summer rains it shoots out over the precipice, which somewhat overhangs, with tremendous velocity.

Lake Chūzenji itself, which is some quarter of a mile or more above the crest of the fall, is noteworthy as being one of the highest in Japan, having an altitude of 4375 feet above sea-level, and a maximum depth of no less than 93 fathoms. Another slender fall, known as Yu-no-taki, pours into it over a shelving black precipice, dropping some 200 feet at a slanting angle. Not far away and on the road leading from Nikko to the lake are the two other falls of Hannya and Hōdō, and, as well, that of Shirakumo, meaning " white cloud." The variegated tints of the maples and other trees which line the banks of the lake make it particularly attractive during the autumn.

Of less height but extremely beautiful are the Shiraito Falls, also in eastern Japan, which, like that of Kegon, descend over a wall of black lava. The largest, which drop 85 feet, are called by the Japanese O-daki and Me-daki, or " male " and " female " ; while some forty other cascades are fancifully regarded as the " children " of these two. Near-by is another cascade known as Oto-dome, or " noise-stopping," so called, as Messrs. B. H. Chamberlain and W. B. Mason relate in their *Guide to Japan*, on account of a legend to the effect that the Soga brothers, when on their way to avenge themselves on their father's assassin, met at these falls, one at the top and the other at the bottom, and that the latter ceased from their roaring to allow the pair to speak with one another ! They are located near Kame-ide and drop 100 feet on a width of 30 feet.

Higher than either of those already mentioned are the Katzura

Falls, which are situated 6 miles inland from the fishing village of that name on the Kii coast. These have a sheer drop of 275 feet into a deep pool, whence the stream runs down a picturesque valley amidst enormous boulders to the sea. The mountains run on either side of the fall in an amphitheatre-like curve, and on their slopes is a Shinto temple some three hundred years old, where pilgrims used to pray to the Unseen Spirit to protect all those who were at sea. The village of Katzura was formerly noted for the number of whales that were caught off that coast.

Of about the same height are the falls of Nachi in central Japan, or rather, their principal leap, which is known as the Great, or First, Fall. Here there are three main leaps, as well as a number of smaller cascades still higher up. They are embowered amidst a growth of luxuriant ferns and mosses. It is related that in the pool below them the Buddhist saint, Mongaku Shōnin, fasted and did penance for three weeks before coming out of the water. Then there is the fall which at one time was fabled to consist not of water but of the most excellent *sake*, namely, that of Yōrō-ga-taki, near Ogaki. It was miraculously revealed in the eighth century as a reward to a certain poor woodcutter who had spent his earnings in providing his aged parent with the spirit in question !

Lastly, we may mention the falls of Mukabaki, near Nobeoka, in the island of Kyūshū, which are 240 feet high, and those of Todoroki-no-taki, near the village of Hirai, and Dogama-naru-taki, both in the island of Shikoku. The former is greatly visited by pilgrims, and Messrs. Chamberlain and Mason state that there are said to be no less than ninety-nine other falls further up the same valley. Of Dogama-naru-taki it is said that the country folk round about believe it to be the dwelling-place of some serpent deity, who also owns it.

CHAPTER XX

THE WATERFALLS OF AUSTRALIA, NEW ZEALAND AND OF THE ISLANDS IN THE PACIFIC

THERE are no "giant" falls either in Australia, New Zealand or the various islands of the Pacific. As far as Australia is concerned, its peculiar physical configuration, and the fact that about two-thirds of its whole area lie within the drought or subtropical zone, would preclude any expectation of finding many notable waterfalls there at all. About one-third of the whole continent has a rainfall of less than 10 inches per year, and, moreover, the coastal and other ranges of mountains are of such low average height, in contrast, for example, to those of New Zealand, that except for the highest peak, Mount Kosciusko, which itself is well under 7500 feet, they bear but little snow, and no great glaciers to swell the streams which descend from them either into the inland lake-beds or, in comparatively short courses, to the Indian and Pacific Oceans.

There are, indeed, no large rivers with the exception of the Murray, and its chief affluent the Darling, and even the mean discharge of the former varies from no more than 2791 cusecs to 6336 cusecs at different points of its course. In 1914 for a time it even ceased to flow altogether. In short, the rivers of Australia, generally speaking, have no great perennial volume at all. They may develop into considerable torrents in the winter, but dwindle in the summer to mere creeks which are but little more than successions of water-holes.

The wettest region on the continent is in the neighbourhood of Cairns in northern Queensland, where, thanks to not infrequent tropical deluges, the mean annual rainfall amounts to 165 inches, and it is there, in the ranges and tablelands back of Cairns that we might expect to find, and, as a matter of fact, do find, some of the principal Australian waterfalls. The most noteworthy of these are the Barron Falls where the river of that name breaks through the coastal range some 19 miles from Cairns. They are situated at the head of a most magnificent gorge formed by two mountain spurs, which rise precipitously on either side to an average height of 2500 feet, and through which one of the finest scenic railways in the world passes to Kuranda about 2 miles above them. Palms, innumerable ferns, and all the luxuriance of tropical vegetation clothe the sides of this great but narrow ravine, which affords a refreshing and striking contrast to the dry interior of the country farther inland.

Some extremely grandiose accounts of the Barron Falls have sometimes appeared in the Australian Press, notably one by a Mr. Meston, who happened to have the good luck to see them after two days of exceptionally heavy rain, which was reckoned to amount to no less than 20 inches. The description in question appeared in the *Sydney Mail* of January 29th, 1887.

"Before me," he wrote, "was a torrent of water 300 yards wide and about 60 feet deep, rushing resistlessly along at a rate of 20 miles per hour, tumbling in a solid wall suddenly over the edge of the enormous precipice, launched clear out into space, and descending for over 600 feet into the 'waste-wide anarchy of chaos, dark and deep,' yawning abysmal in the depths below. I look up the river and see it come sweeping round the bend, divided into three streams that rush together like wild horses as they enter the straight in the dread finish of their last race. . . . They roll over the cliff, strike the first ledge of rock, and the water is dashed into foam and mist; rolling billows of vapour are projected with terrific force in vast fantastic forms down the entrance of the titanic avenue of the river beneath, and clouds of spray float away for 1000 feet and condense and drip in showers of emerald dew-drops from the trees on the slopes of the mountains. The currents of air created by the cataract waved the branches of trees hundreds of feet overhead as if they were swayed in the contending winds of a storm. The thunder of the waters was awful. The rocks shook beneath you like a mighty steamer trembling with the vibrations of the screw. The very soul within you recoils appalled before the inconceivable grandeur of that tremendous scene. . . . At intervals there are deafening explosions like the discharge of enormous cannon, and the waves of spray roll out like cannon smoke, and recoil upon themselves with the force of the impetus, to be swallowed up in the downward-driven current, and finally swept into the abyss."

As might be imagined, the readers of the journal in question who had never seen the cataract were considerably astonished to learn that Australia boasted such a Niagara! At the same time, however, a subsequent visitor to the falls gave it as his opinion, after careful observation, that at very high flood both the breadth and volume of them as given by Mr. Meston might not, after all, be so great an exaggeration as was supposed; though at such a time he considered that the piling up of so vast a mass of water in the narrow chasm below would shorten the drop by as much as even 300 feet.

Those, of course, who expect to see the Barron Falls in anything like the state above depicted will be grievously disappointed, except after the most unusually heavy and prolonged downpour of rain. In their normal state, as another writer remarks : " They are pretty, only that ; pretty and pleasing. Not stupendous, not exciting, not awe-inspiring—not at all . . . The Barron Falls are not falls at all. They are a series of cascades covering a mile and a half. The height from the top of the cascades to the bed of the river is a thousand feet."

The two views here reproduced showing the falls at low water and during a high flood will give the reader a good idea of the different aspects they present. The correct height of the actual falls is approximately 600 feet, but from the point where the stream begins to descend to the bottom of the chasm it is about 900. They do not fall in a sheer leap, but come down at a steeply sloping angle, plunging from rock basin to rock basin in isolated threads of water when the river is low. These basins have been compared to hollow steps in the stairway of a pyramid. At the foot of the cataract a huge rock divides the raging torrent into two parts, at the farther end of which they meet in a narrow V-shaped channel and thence rush surging down the boulder-strewn gorge.

The falls are now being harnessed for power, if indeed the work is not already completed, by the erection of two dams across the low-water channels at their crest, so that except when the stream is in spate little or no water seems likely to pass over them at all. The usual fatuous statement is, of course, made that the scheme will not interfere in any way with the beauty of the falls !

Other noteworthy falls in this region are the Tully Falls, which are located about 17 miles from Ravenshoe, which is at the terminus of the railway from Cairns and 103 miles distant from it. I have not been able to find any detailed account of these falls, which are said, however, to drop 885 feet and to be finer than those on the Barron River. They are probably of much the same order in their variation from a thin stream at low water to an imposing torrent in spate. Other falls in Queensland occur on the Bloomfield River ; but here, again, any details are difficult to find. One of the falls is said to be about 5 miles up from the river's mouth with a height variously estimated at from 180 to 200 feet, while another farther up is said to descend for 400 feet. The volume of the river would appear to be considerably greater than that of the Barron.

It is in New South Wales that most of the rest of the Australian

falls are to be found which are of any particular interest; and one of these, the Bathurst Falls on the Apsley River 16 miles from Walcha, was first discovered by Oxley on his second journey, thus being among the earliest waterfalls to be seen on the continent. It was in the first quarter of the last century that Oxley, then Surveyor-General of Lands, came upon them.

They so far "surpassed anything which we had previously conceived even to be possible," he writes, "that we were lost in astonishment at the sight of this wonderful natural sublimity, which perhaps is scarcely to be exceeded in any part of the eastern world (!). The river," he continues, "after passing through an apparently gentle rising and fine country, is here divided into two streams, the whole width of which is about 70 yards. At this spot, the country seems cleft in twain, and divided to its very foundation: a ledge of rocks two or three feet higher than the level on either side divides the water in two, which, falling over a perpendicular rock 235 feet in height, forms this grand cascade. At a distance of 300 yards, and an elevation of as many feet, we were wetted with the spray which rose like small rain from the bottom: the noise was deafening; and if the river had been full, so as to cover its entire bed, it would have been perhaps more awfully grand, but certainly not so beautiful. After winding through the cleft rocks about 400 yards, it again falls in one single sheet upwards of 100 feet, and continues in a succession of smaller falls about a quarter of a mile lower, where the cliffs are of a perpendicular height on each side exceeding 1200 feet, the width of the edges being about 200 yards. . . . This most magnificent fall and the river itself were respectively named Bathurst and Apsley in honour of the Noble Secretary of State for the Colonies."

Below these falls, Oxley had previously discovered another fine fall which he named Beckett's Cataract after the then Judge Advocate General. He depicts it as falling in one unbroken sheet over a perpendicular rock at least 150 feet in height and, after winding through the glen for half a mile, joining the main stream lower down. (*Journals of Two Expeditions into the Interior of New South Wales*, by John Oxley, 1820.)

Curiously enough, I have not come across any modern accounts of these falls. Possibly, as appears to be the case with some of the other waterfalls in Australia, they have been re-named.

Some 29 miles from Armidale and 358 from Sydney are the Wollomombie Falls which have from time to time been described in the Australian Press. I have not noted any authentic figures as regards their height, so those here quoted must be taken with a certain amount of reserve. At the point where the falls occur, two rivers, the Wollomombie and the Chandler, are said to plunge down into a terrific chasm of a depth of some 1700 feet. The fall on the Chandler is about 2 miles higher up the gorge than its neighbour, and pours into it in a beautiful curved sheet.

The Wollomombie Falls, carrying a greater body of water, plunge sheer for 1100 feet before meeting with any obstruction, and then rage down the rest of the descent over a steep slope, at the foot of which an immense rock, bleak and bare and black, rises from the floor of the ravine to an alleged height of 600 feet. It is at the base of this rock that the two streams meet, after which their combined waters swirl madly down a remarkable gorge, hemmed in by sheer cliffs, which is said to wind from the neighbourhood of Armidale down to the Macleay River, a total distance of some 100 miles. Their setting of dark and barren precipices contrasting with the luxuriant growth of ferns and other vegetation at the bottom of the ravine render these falls especially striking, and to judge from a coloured lithograph of them, of which, unfortunately, I have not been able to obtain a copy for reproduction, they would appear to provide, especially when in spate, the finest spectacle of the kind on the Southern Continent.

It is in the lovely Blue Mountains of New South Wales that we find, within a comparatively short distance of each other, the most numerous collection of cascades in Australia. Nearly all of them, however, occur on very slender streams, little more, indeed, than large brooks, and are distinguished rather for the beauty of their surroundings than for anything like great volume ; though at the same time the heights from which they drop are often impressive. Most of these cascades can be reached to-day from Sydney in little more than a couple of hours by rail, and the most impressive of them are no more than between 50 and 80 miles from the capital. Katoomba, 68 miles away, is one of the best centres for visiting them.

The late David Christie Murray has well described a view over the Katoomba valley : "We stood," he writes, "upon the fenced edge of a precipice which fell sheer for hundreds and hundreds of feet. Below, walled on two sides by precipitous and titanic towers of rock, dull red and orange and grey, lay a vast undulating valley, grey with billowing gum trees. To right and to left bold headlands jutted out like islands in the sea. Far off one huge table mountain stood up as if in menace over the valley, and far beyond, fold on fold, the mountains rose weird and strange alike in form and tone. The landscape seems scarcely of the earth at all. Form and colour are alike unaccustomed, alien; I felt as if I stood upon the borders of an unknown world."

Here are the Katoomba Falls which fall in two leaps, divided by a sloping cataract over precipitous rocks. The upper fall is 180 feet, and the total descent according to the figures of Mr. G. C. Stewart, Surveyor to the Lands Department, is 540 feet from the look-out, 60 feet above the falls' crest, to the bottom. On either side the cliffs rise to 1000 feet and more. The water babbles over numerous low cascades before reaching the edge of the precipice, fed by several tiny rivulets which unite before it takes its leap

Some 5 miles away are the Leura Falls, plunging down through fern-clad walks in two main leaps of 166 and 142 feet, with an aggregate descent of 380 feet. Then, of greater volume than either of these, there are the Wentworth Falls, formerly called the Weatherboard Falls after the Weatherboard Inn on the near-by Bathurst road. Here again there are two chief leaps, the upper of 360 feet and the lower of 158; the total height of the whole drop being about 614 feet. Above the crest of the first leap the stream commences its descent by a series of rapids, then plunges into the abyss and breaks up at its foot into feathery spray. These falls were also known at one time as the Campbell Cataract.

Lastly, passing over a score or two of minor cascades, we may mention the famous Govett's Leap, so named after W. R. Govett who discovered it. The fall itself, of which the main leap in the clear is 537 feet, is but a slender stream; but it is the chasm into which it descends, some 3000 feet in depth, that is the arresting spectacle here. The discoverer of the fall wrote:

"The chasm or aperture of the mountains, which apparently yawns for the small stream, is like an amphitheatre, and the water gliding into it seems again transformed into its parent vapour, for, not long after its fall, it assumes a misty appearance and a moment's gaze into the dark void is sufficient to appal the stoutest heart. When, however, fear is overcome by curiosity, and the brink of the precipice is approached, wonder is increased at every step by the dreadfully steep and perpendicular sides, the frightful depth of the gulf, the whispering echo of the place, and the deep hollow-sounding crash of the waters."

The breadth of the fall is said to be about 20 feet, though at a distance it looks but a mere thread. Lower down in its course the Grose River, of which Govett's Leap is one of the sources, forms another and more voluminous fall known as the Victoria Falls, dropping 100 feet on a width of 50 in a deep gorge. Both above and below these falls the river is also precipitated over a series of terraced cascades.

The famous Jenolan Caves, by the way, are no great distance from Govett's Leap. They were discovered in 1841 by a Mr. Whelan and two mounted police while in pursuit of a notorious bushranger named McEwan.

The concluding Australian waterfall that may be mentioned, also in New South Wales, is on a tributary of the Shoalhaven River about 21 miles from the township of Robertson. These are the Fitzroy Falls, which plunge in two leaps, the upper of 400 feet and the lower of 200, into a ravine which is said to be 1000 feet deep. They are not of any great volume, but the ravine itself is noteworthy, both for its sudden and unexpected situation in a gentle undulating country, and for the number of magnificent cedars, ferns, rock lilies and picturesque cabbage-palms which clothe its floor and sides.

Before passing to New Zealand, we may note some pretty cascades in Tasmania, of which the Wellington Falls, not far from Hobart town at the head of Mountain River in Buckingham County, are generally regarded as the finest. They descend in a series of leaps over the face of a steep cliff into a boulder-strewn gorge, the drop being variously estimated at from 203 to 250 feet. Others are the falls on the Snug River, which have a height of about 130 feet and are surrounded with the most luxurious vegetation ; and the falls of the Meander, near Doloraine, said to be of considerable height and extremely fine after heavy rain.

When we come to New Zealand we have a very different condition of things from that prevailing in Australia, and though, like the latter, it boasts no " giant " waterfalls, it has a considerable number of imposing cascades. Mr. Evan Parry, indeed, the Chief Electrical Engineer, estimates the total horse-power capable of being furnished by the New Zealand falls at 4,870,000, of which the South Island accounts for 4,100,000 ; while Mr. P. S. Hay, Government Engineer-in-Chief, after deducting sources of under 1000 h.p., puts the total at 3,700,000 h.p., assigning to South Island 3,200,000 of that amount. The increase of the use of the various falls for power may be gathered from the fact that whereas

in 1919 the amount of installed horse-power was 49,000, it was augmented by 1930 to approximately 240,000 h.p., and is probably considerably more to-day.

As will be gathered from the above, it is in the South Island that there are the most numerous falls, and of these the most notable occur in the region of Milford Sound on the south-west side of it. The various Sounds and Inlets of the Island have not unjustly been compared to the Norwegian fjords, but with the added attraction of far more varied and lovely vegetation.

The finest falls in the region indicated, and indeed the finest in all New Zealand, are the Bowen and the Sutherland Falls. With the possible exception of the Te Huka Falls in the Northern Island, which, however, are of no great height, the Bowen Falls have probably more volume than any others. The stream is fed by glaciers, high up and unseen, on the Barren Ranges of 5125 feet altitude, and the falls seem to a spectator below them to emerge suddenly from a rocky ledge far aloft on the mountain side as if they sprang from the sky. Mr. W. S. Green in his book, *The High Alps of New Zealand*, writes :

" When about eight miles from the open sea a booming sound rose high over the voices of the numerous cascades, growing louder as we advanced, and rounding a forest-clad point we came upon the grandest of New Zealand waterfalls the great Bowen Fall. Its first fall is only about 50 feet into a rock basin, but leaping from it upwards and outwards in a most wonderful curve, it plunges down with a deafening roar in a single leap of 300 feet. The Te Anau was allowed to drift up in the eddy caused by the fall, and being caught by the stream in the midst of drenching clouds of spray, she was spun round as though she was a mere floating twig."

It is its extraordinary rebound into the air from the rock basin above mentioned which particularly distinguishes this fall, causing the water to shoot out and up with tremendous force and then to descend again in a seething mass of foam and spray. Mr. Green, by the way, has considerably underestimated the height of the falls, which totals 540 feet ; the first plunge into the rock basin being 70 feet, and the second leap being 470. Some years ago a scheme was mooted to harness these falls to supply power to a large electrical plant for extracting nitrates from the air, but I am not aware if it has been carried into effect.

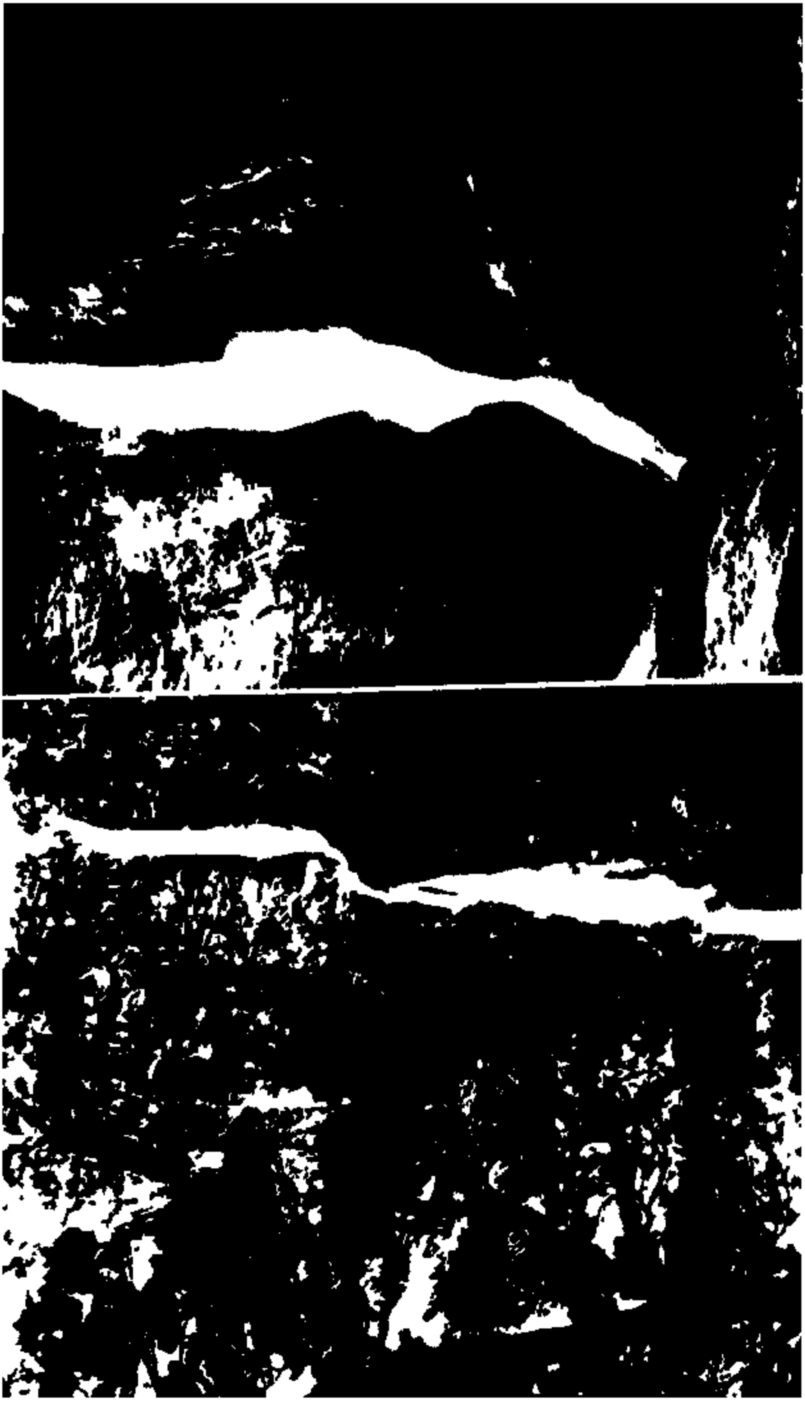
Dwarfed though they are to a great extent by the titanic precipices and soaring forest-clad slopes which hem in the narrow sea-ways of the Sound on either side, the Bowen Falls were long reputed to be the highest of any on the island. In or about the year 1880, however, a man named Donald Sutherland, known as "the Hermit of Milford Sound," who for some ten years previously had led a lonely life exploring and prospecting in that region, discovered a far higher fall which is now named after him, and is, indeed, one of the highest on the globe. His first estimate of its total descent, based on the supposed altitude of the surrounding mountains, was no less than between 4000 and 5000 feet, though he afterwards admitted he had not been nearer to it than a couple of miles and that its lower section had been hidden from view.

A few years later, namely, in 1883, Messrs. S. H. Moreton, an artist, and W. P. Hart, a photographer, set out to investigate it, taking Sutherland and his mate, Mackay, with them. In those days it took them two days of hard travelling to reach their objective; first from the Bowen Falls to the head of Milford Sound, thence to Lake Ada and across the latter by boat, and finally some 10 miles through thick bush; a distance of about 20 miles in all. To-day, of course, an easier track has long been cut by the Colonial Government, rendering access to the falls much less arduous for tourists.

Mr. Hart concluded that the Sutherland Falls were seven times the height of the Bowen and had five times the volume; a great exaggeration in both respects. Their correct height has since been found to aggregate 1904 feet, which is sufficiently respectable. They consist of three leaps, the first of which is 815 feet, the second, 751, and the third, 338. Each fall is a sheer leap in the clear, and each plunges down into a rock basin throwing up immense clouds of mist and spray. When seen at about a quarter of a mile's distance, the whole fall appears to consist of a single straight leap with two breaks.

The inevitable comparison with the Yosemite Falls, which, as we have seen, are still higher, has often been made; and it is generally agreed by persons who have seen both that the New Zealand wonder carries by a good deal the larger volume, and for that reason is not dissipated at its base into fine vapour as is the case with many very high but slender falls. The surrounding scenery also, if anything, surpasses in grandeur even that of the Yosemite. The Arthur River, on which the falls occur, takes its rise in an immense glacier and thence pours out through a narrow defile at the summit of the precipice.

Another fine fall pouring into Milford Sound is the Stirling



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Fall, 510 feet in height. As the photograph shows, it has a marked resemblance to some of the falls on the Norwegian fjords. I am indebted for the view of it, as well as for those of the other New Zealand falls here shown, to the kindness of the High Commissioner for New Zealand.

Not far from Milford Sound, again, are the Lennox Falls, so named after Lord Walter Gordon Lennox, which descend from glaciers on the slopes of Mount Earnshaw 6000 feet above the valley. They are three in number and vary from 100 to 300 feet in height, with widths of from 15 to 40 feet according to the volume of water at the melting of the snows. Mr. R. W. Payton, in his *Round about New Zealand*, says of them : " In its descent over the high rock the water struck innumerable little projections, sending out showers of spray in every direction. A little more than half-way down a colossal rock jutted out half-way across the fall, and turned off a large body of water to the right, thus breaking the otherwise straight line in a very picturesque way. Altogether it is one of the most beautiful falls I ever saw."

It finally pours into a dark pool hedged about with enormous moss-covered boulders. One of the cascades has been named " the widow's tears," but for what reason it is not easy to discover.

It would be impossible to describe all the very numerous waterfalls in New Zealand, but, as a last example, we must include the Te Huka Falls, to which I have already alluded, on the Waikato in the North Island. These falls, I think, have been harnessed for some time past. Though of no particular height, their volume is probably the greatest of any of the New Zealand falls. The stream, which is a very considerable one, issues from the mysterious Lake Taupo, about which the Maoris had many strange legends. Its waters, especially in the shallower parts, are often strangely agitated by subterranean volcanic forces, and it was accordingly fabled that they were inhabited by the *Tanuhas* which have been described as being like monsters after the order of our fabulous dragons but without wings. Above the falls the river narrows into a chasm of only some 30 feet in width between high perpendicular walls, thus acquiring great velocity as it shoots out into the ravine below.

Mr. Payton relates that many years ago a party of natives who were visiting some friends near Lake Taupo were boasting of their skill in managing their canoes, whereupon their host told them he would show them a stream which they would be unable to navigate. They accepted the challenge, and sixty of them in a big canoe started to descend the River Waikato. Too late, as they neared the falls, they discovered their mistake. One man alone managed to jump ashore in time; but all the others passed over the cataract into the deep pool below, whence they never more emerged.

Of the many waterfalls which must no doubt exist in the larger islands of the Pacific, such as New Guinea, Borneo, Java, etc., any accounts are few and far between. As regards the latter island, the late Dr. F. H. H. Guillemard, who collected a good deal of data relating to many well-known falls, has left a short note referring to two waterfalls of which I have been unable to find any further details. These are what he describes as the great falls of the Tji-Taroem near Fji-Jabang, and those of Tiuruk Almian. Of the first he says:

"The river descends at this point through a narrow cleft in the rock, more than 1000 feet deep, forming thus the grandest waterfall in Java as it breaks through the western barrier range of the plateau of Bandang, consisting of porphyritic greenstone, trachytic basalt and perpendicular cliffs of chalk. Below this, after a series of splendid cascades, it becomes a navigable stream."

And of Tiuruk Almian, the dust or vapour fall, which is apparently a separate fall, he goes on to say that "it is the finest waterfall of the Tji-Taroem, which is precipitated over a precipice of greenstone 40 feet in height."

An important waterfall in New Guinea occurs on the Laloki, or Laroki River, about 23 miles from Port Moresby. It is known as the Rouna Falls, and, according to the Rev. James Chalmers, was first discovered by some mining prospectors in 1878. Mr. Chalmers made more than one visit to these falls. He describes the river as pouring over a succession of small cascades for some half a mile before reaching the main leap where it shot out "into the boiling cauldron below." On his second visit he attempted to measure the height of the cataract, but says he could not get near enough to the bottom to give correct figures. He reckoned it, however, to be 256 feet.

The Rev. W. G. Lawes, who with his wife accompanied Mr. Chalmers on that occasion, wrote: "The stream is broken just above the falls by a large boulder, lying at an angle of about 45 degrees. It would measure about 60 feet long on its upper face. Between this and the falls is a small rocky garden, with creeping palms and tropical vegetation. Just at the brink are several bare rocks midstream, although these are all covered, the natives told us, when the river is high. The principal fall is on the eastern side; the greatest body of water falls over here, but about 100 feet down it breaks on a flat perpendicular rock. On the western side there was less water, but it is a sheet fall right to the bottom, where there is a terrible cauldron."

A more recent account of these falls appeared in the *Geographical Journal* of December, 1925, from the pen of Mr. T. J. Lindsay Dowsett, who writes that "for beauty, picturesque surroundings and prospects of immediate economic development," they "rank with any other falls within the Empire." He states the height to be 210 feet and the width at the crest, at the time he saw them, to be 30 yards. Below them the river has a very rapid descent, dropping 320 feet in 100 yards, and 800 feet within 4 miles. The average depth of water in the gorge during May he states to be about 6 feet. He found another low fall of 25 feet some 150 yards above the main one. His estimate of the volume, however, seems very much on the low side as he calculated it at no more than 16,000 cubic feet per *minute*, or only 266 cusecs, sinking to 12,000 cubic feet per minute, or 200 cusecs in August, the driest month; though, as he further states, this would be enormously increased in the flood season from November to February. He assessed the horse-power in the dry period to be from 20,000 to 40,000.

On one side of the gorge there rises a precipitous mass of rock, and on its southern slope there is an extinct crater, reputed, as Mr. Dowsett tells us, to be inhabited by numbers of pythons, and from which, centuries ago, the enormous boulders which lie scattered all over the neighbouring country were ejected. At the time Mr. Dowsett wrote, a concession had recently been granted to a private company to harness the falls for treating the copper ore obtained from the mines in the Astrolabe Mountains near-by; no doubt it has been carried into effect ere now.

Mr. Wilfred Powell, F.R.G.S., in his *Wanderings in a Wild Country* mentions an imposing fall in the Island of New Britain, or New Pommerania, one of the largest of the Bismarck Archipelago lying to the north-east of New Guinea. These falls occur on the Unamulla or Holmes River on the south-western side of the Gazelle Peninsula. Set in the midst of the most gorgeous tropical vegetation, the river plunges down into a deep pool in a sheer leap of about 400 feet, the width at the crest being 20 yards. Looking up at the top of the falls, Mr. Powell described it as being "lost in mist," so great was the rise of the spray from the concussion of the waters.

The beautiful Rainbow Falls in Hawaii, about 3 miles from Hilo, are noteworthy on account of their unusual situation. Here the torrent pours out in a single white sheet from an extinct crater, now filled by a lake about two-thirds of a mile in diameter. As in the case of Kaieteur and some other falls, the rebound of the waters at the base of the cataract has hollowed out at the back an immense cavern in the rock, which the ancient Kanakas fabled was the haunt of a monstrous animal, half-fish and half-human, who killed everyone who dared to bathe in the pool. This was possibly an invention to deter anyone from doing so, as the rush of the waters created by the fall is so great that even such experienced swimmers as the natives would be in serious danger if they ventured into it. The falls derive their name from the exquisite and varied colouring of the falling water when the afternoon rays of the sun strike obliquely upon them ; an optical phenomenon which regularly occurs except when the day is overcast.

Finally, we may note the Fuatawah Falls in Tahiti, and the Silver Thread Cascade in Samoa. Of the former the late Lady Brassey wrote in *The Voyage of the "Sunbeam"* :

" A river issues from a narrow cleft in the rock, and falls at a single bound from the edge of an almost perpendicular cliff, 600 feet high, into the valley beneath. First one sees the rush of blue water, gradually changing in its descent to a cloud of white spray, which in its turn is lost in a rainbow of mist." She compared it to a Staubbach with a background of verdure-clad mountains.

The Silver Thread Falls have been described by Mr. W. B. Churchward in his book, *My Consulate in Samoa.* He depicts them as tumbling over the edge of a precipice which shuts in the whole valley like a wall. The river pours out through a rent in the solid rock, dropping some 400 feet, and flashing so brightly in the sunlight as to be visible to an observer at Apia quite a distance away. " The thick body of water," he writes, " continually passing by us appeared in falling to get thinner and thinner, until, dwindling to a silver thread, it ended in snowy-white fleecy mist—the spray dashed up by the heavy falling flood." Seen from the base, it appeared like " an immense ever-rising fountain shower of feathery spray, dashed up by the everlasting crashing of the superior waters from their giddy height into the pool below."

CHAPTER XXI

THE WATERFALLS OF EUROPE: THE ICELANDIC AND NORWEGIAN FALLS

AS I have already pointed out in my opening chapter, though there are no falls in Europe which for their combination of height, width and volume can rival the chief of our "giants" in South and North America, Asia or Africa, there are a few whose maximum discharges in their flood seasons place them very high in the scale, in that respect at least; while there are also quite a number which for height and beauty need fear little comparison with any others.

It is in northern Europe, in Iceland, Norway and Sweden that we find by far the finest and most formidable waterfalls. The main reasons for their greater abundance and volume among the mountain ranges of Scandinavia as compared with those of the Alps or Pyrenees, are partly the greater rainfall on the northern fjelds, and the fact that the latter are both wider and more flat than the more southern uplands, while the valleys between them are deep and far apart.

As Mr. James D. Forbes well observed in *Norway and its Glaciers* (1851): "The surfaces of the former," i.e. the fjelds, "receive and collect the rain, which is then drained into the narrow channels of the latter, and as the valleys ramify little, but usually preserve single lines, and are wholly disconnected from the fjelds by precipitous slopes, it follows that the single rivers which water these valleys represent the drainage of vast areas, and are supplied principally by streamlets which, having run long courses over the fjelds, are at last precipitated into the ravines in the form of cascades."

As he further points out, these Norwegian plateaux, owing to their heights, are snow-covered for about two-thirds of the year, during which time many of the streams become extremely low and, in many cases, quite dry. But during the long summer days, the whole of the accumulations of the autumn, winter and spring are thawed out, resulting in an immense amount of drainage being concentrated into a very short season. The Alps and the Pyrenees, on the other hand, have no such tablelands or plateaux, while the character of their valleys is far more ramified; and hence their cascades are both less numerous and of less volume.

Two of the finest of the northern waterfalls, which is to say two of the finest in Europe, occur in Iceland; namely, those of

Dettifoss on the Jokulsa River in the north-eastern part of the island, and Gullfoss, or Golden Falls, on the Hvita River in the south-west.

According to Sir Richard Burton in his *Ultima Thule*, both these rivers range from 100 to 150 miles in length ; and, as he further observes, their volumes and the dimensions of their basins are "out of all normal proportion to the area of the island." It has not been very easy to get any accurate figures as regards these falls, but through the good offices of Mr. Asgeir Sigurdsson, the British Consul at Reykjavik, I learn from Mr. G. Zoëga, Director of Roads for Iceland, that the heights are respectively 190 feet in the case of Dettifoss, and 164 feet in the case of Gullfoss. He does not give their widths, but states further that Dettifoss can furnish 240,000 h.p., and Gullfoss 60,000 h.p.

Mr. J. Plass of the Royal Board of Waterfalls of Sweden has kindly worked out these amounts of horse-power for me as being equivalent to 14,585 cusecs in the former case, and to 4238 cusecs in the latter. The figures, however, seem decidedly on the low side, and, as he, Mr. Plass, says in his letter, they "refer probably to mean flow volumes during six to nine months, and the maximum flow volumes should be expected to be considerably higher."

It will be noted that Dettifoss is considerably the larger fall of the two, though it has been visited far less than the other. One of the best accounts of it was written by the late Mr. Baring-Gould, who describes the chasm into which the Jokulsa plunges as "a frightful fissure formed in the basalt about 200 feet deep, with the sides columnar and perpendicular. The gash terminates at an acute angle, and at this spot the great river rolls in." He considered that this fall was not only the finest sight in Iceland, but quite unequalled in Europe.

"The wreaths of water sweeping down," he writes, "the frenzy of the confined streams when they meet, shooting into each other from either side at the apex of an angle ; the wild rebound where they strike a head of rock, lurching out half-way down ; the fitful gleam of battling torrents obtained through a veil of eddying vapour ; the geyser spouts which blow up about 70 feet from holes whence basaltic columns have been shot by the force of the descending water : the blasts of spray which rush upwards and burst into fierce showers on the brink, feeding rills which plunge over the edge as soon as they are born ; the white writhing vortex below, with now and then an ice-green wave tearing through the foam, to lash itself against the walls ; the thunder and bellowing of the water, which makes the rock shudder under foot, are all stamped on my mind with a vividness which it will take years to efface."

The setting of Gullfoss on the Hvita or White River, so-called because of the milk-like colour of its glacial waters, is no less stark and savage than that of the great leap of the Jokulsa. Nor is it only the barrenness of its surroundings that leaves an impression of grim desolation on the mind of the visitor. It is one which is inevitably heightened by the reflection of the propinquity of the falls to the Thingvalla, or ancient Assembly Plain, from which they are no more than from two to three hours' ride, and where criminals, after condemnation, were hurled from a high rock into a near-by abyss or, if they were wizards or witches, were burnt at the stake.

As will be gathered from the photograph of these falls, for which, as well as for that of Dettifoss, I have to thank Mr. Olafur Magnusson of Reykjavik, above its main leap the Hvita descends over a series of rocky terraces, which are said to aggregate about 38 feet in height. The great fall lies lower down, practically at right-angles to these, and is divided into two parts by a rocky islet. The terraces are flanked on either side by stark cliffs of basalt which tower aloft like immense organ pipes, and resound with the roaring of the torrent as it cascades down between them.

It was Goldfoss that the late Sir Rider Haggard selected, with a certain amount of romantic colouring as to details, as the scene of one of Eric Brighteyes' early exploits in the Homeric romance of that name, which its talented author, by the way, once told me he considered to be his best book. Readers of that arresting tale will recollect how Eric, accepting the challenge of Asmund, the priest, to come down to Middalhof by way of the falls, waded and swam across to Sheepsaddle rock on the brink of the cataract, thence lowered himself by a rope to Wolf Fang crag, projecting like a tooth through the flood which thundered down on either side of it, and thence, again, leapt 70 feet into the pool below, from which he finally emerged, dazed but sound, to grace the great feast where the welcome of Gudruda the Fair made him ample recompense.

Mr. W. Bisiker, F.R.G.S., in his book, *Across Iceland*, has expressed the opinion that Gullfoss is one of the finest waterfalls in Europe, and is only surpassed in grandeur, if at all, by one or two others in Iceland itself. No doubt he had Dettifoss in mind; and these two certainly stand out as the greatest of Icelandic falls, though Godalfoss, Bruara and one or two others are worth visiting.

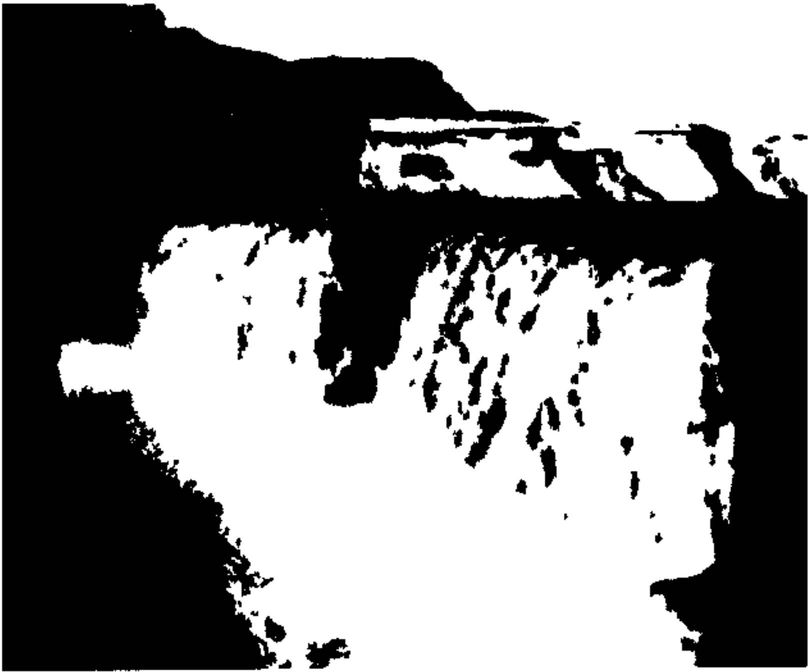
Gullfoss conveys an impression of tremendous power, and at the same time a suggestion of calm, inexorable fatality, which, as a French writer who described it as "bien la reine des cascades Islandaises" observes, "vous prend à l'âme, vous terrasse et vous laisse muet, sans pensée." Most beautiful, too, in contrast with its harsh setting, are the rainbows which sometimes stretch like the frail and fairy bridge of Bifrost across the snow-white sheet of the descending flood, seeming to link one bastion of the gulf to the other, as also are the effects of the sun-rays which fleck the white curtain with golden glints, and shoot it through and through with blue and green and crimson iridescences in a constant play of colour, while the dull roar of the cataract alone breaks the heavy and unchanging silence of the surrounding desolate plain.

After receiving its tributary, the Sog, from Thingvallavatn, the Hvita River is called the Olfusa, and it finally enters the sea near Eyrarbakki.

The total water-power of Norway, representing turbine horse-power which can be utilised for about nine months in the year, amounts, according to Lieutenant Serrander, to as much as 7½ millions, and that of Sweden to 6·2 millions, as compared with 1·5 millions for Switzerland. It is Norway which has the distinction of boasting the greatest waterfall in Europe, as far as volume is concerned, namely, that of the Sarpsfoss on the Glommen, which is easily the greatest river of the country, having a length of about 350 miles. For the figures relating to both this and other Norwegian waterfalls, I am much indebted to Mr. S. Mollerud, the Chief of the Vassdrags-og Elektrisitetsvesen, Oslo.

Though slightly less than 66 feet in height, these falls have a low-water volume of over 8687 cusecs and a mean flow of over 24,190. But at the time of maximum flood the discharge may be over 141,259 cusecs, a figure which, as we have seen, is very seldom attained even by the Victoria Falls during their high-water period. At the brink of the falls, the river narrows to about 160 feet, and the water thunders down over a rocky ledge in a series of cascades. The falls have for some time been harnessed, to the extent, I believe, of about 50,000 h.p., and the available water-power is reckoned to be 64,800 h.p. The power is chiefly utilised for saw-mills and factories.

The three most famous waterfalls in Norway, however, each



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of which has often been singled out by various writers as the finest, from a scenic point of view, in Scandinavia, are the Rjukanfoss, the Skjaeggedalsfoss and the Voringfoss; to which some would add Vettisfoss, whose sheer leap in the clear is higher but of much less volume, as equally fine. The first of these, alas, practically exists no longer.

"Up to 1906," writes Mr. S. C. Hammer in his book, *Things Seen in Norway*, "this magnificent cataract, the name of which is derived from the veil of foam 'reeking' above it, hurled its volumes of water from a height of 105 yards into the fantastic depth below. It was the pride of the Telemark and the object of admiration of three generations of tourists. Six years later the Rjukanfoss was harnessed for industrial purposes and disappeared from view; it now runs through a number of gigantic tubes into a power station of proportionate dimensions."

Another writer, Mr. S. J. Beckett, states that "it feeds the largest single water-power station in the world, producing 330,000 h.p., and has brought into being and supports a town of 10,000 inhabitants."

I have already had occasion, in the case of Niagara, to deplore the spoliation of such wonders of natural scenery as the Rjukanfoss and its kind. One recalls the time when the destruction of the falls of Foyers in Scotland, which Coleridge described as one of the five finest things in that country, aroused strenuous though vain opposition, including the strongest protest from John Ruskin among many others. But to-day we appear to have become so increasingly materialistic in outlook that the obliteration of even the finest waterfalls for industrial purposes scarcely even arouses comment, except for the voices of the few who are nowadays regarded as out-of-date sentimentalists.

It would, of course, be absurd to expect in such a country as Norway, whose enormous resources of water-power are among her chief assets, and whose remarkable industrial development in recent years has been very largely due to that fact, that so easy and obvious a source of wealth would be ignored; but at the same time, so numerous are her waterfalls, one cannot but consider it a thousand pities that so famous an example of them as the Rjukanfoss might not have remained exempt. Nor is the objection one to be entertained merely by artists, or poets or "cranks."

If one looks beyond purely material benefits, is it after all so certain that the finest racial qualities of the Norwegians, which have largely been developed from the simple and peaceful conditions of life that have hitherto prevailed in her rugged and lovely valleys and fjords, may not to some extent deteriorate when those same valleys rapidly become raucous with the hideous clang and clamour of the factory, and when their whole lengths and breadths, except for the unsuitable slopes and summits of the mountains which flank them, shall become the dreary sites of crowded communities?

Mr. G. Gathorne Hardy in his book, *Norway*, has a good deal to say about the rapid transition which is taking place in that country from purely agricultural to industrial conditions, mainly owing to this very exploitation of water-power. He is of opinion that such "advance" has been too rapid, and he further writes that in the case of Norwegians who have emigrated to the U.S.A. and have returned, "too many have lost the engaging characteristics of their race and have become Americanised," and that some, at any rate, have come back in a "deteriorated condition." I certainly cannot say that I observed anything of the kind myself; but, however that may be, I am not in agreement with the further view he expresses, namely, that the objection that the harnessing of waterfalls for industrial purposes ruins the beauty of the countryside is a "somewhat sentimental one," and "to a great extent without foundation." He writes:

"If anyone were privileged a century hence to revisit Norway, he would, I think, feel comparatively at home. The floor of the valley would indeed hold more and larger buildings than of old; but the salmon would still leap in the unpolluted waters of the same familiar stream. The same forests would clothe the hillsides, where they became too steep for building. And, above all, in an ether pure as of old, dwarfing and confining in impassable limits the proudest advance of industrial civilisation, the mountains would lift their changeless peaks to the eternal snows."

And again, speaking of the "inexhaustible" sources of water-power, he says: "If the day ever comes, as presumably it must, when the coal of the world is all consumed, that day will still hear the waterfalls of Norway roaring over their precipices."

I must confess that Mr. Hardy's forecast of the future appearance and condition of what are now the beauty spots of Norway seems to me quite falsely optimistic and altogether too much tinted in *couleur de rose*, judging by the transformations which have taken place in other parts of the world in similar circumstances. To take just one instance, one need only mention the present condition of the Velino valley near the falls of Terni. No, the Norwegian mountains may indeed still "lift their changeless peaks to the eternal snows," but that the same forests will still clothe the hill-sides, that the air will be as pure, or that the streams will remain either familiar or unpolluted, I beg leave very greatly to doubt.

One thing, moreover, is quite certain, namely, that the sorry visitor of that day will not be in the least likely still to hear the waterfalls of Norway, which, apart from her fjords, are her peculiar and crowning glories, "roaring over their precipices." The only signs of their former existence will far more probably be thousands of enormous pipes disfiguring the hill-sides when the mournful example of the Rjukanfoss shall have been multiplied a hundredfold.

The place where the Rjukanfoss formerly leapt down in its might is at the head of the narrow valley of Vestfjordal, leading up from Vestfjord in the Telemark district; it is the river Maan which rises in the Mjøss Vand that supplies its volume.

In the old days one approached it by a rude flight of natural steps, passing from rock to rock, and finally, in order to get the finest view, one followed a precipitous, almost inaccessible path along the rampart of the mountain, known as the Marie Stigen on account of a story which Frederica Bremner relates in her *Strife and Peace*. It was here, they say, that the beautiful Marie of Vestfjordal, unknown to her parents, used to go to meet her lover, one Ejstein Halloordsen, till one sad day their liaison was discovered and Ejstein was obliged to leave the district for fear of the vengeance of Marie's father.

On the latter's death after many years, Marie, still faithful, recalled her lover, and in his eagerness to come to her by the shortest way he descended this path by the Rjukanfoss, while she awaited his coming on the other side of it. As soon as he appeared she cried aloud with joy, stretching out her arms to welcome him. He hurried forward, but in his excitement his foot slipped, and he suddenly fell over into the cataract and was lost in the reeking abyss. Marie became insane; and henceforth day after day till she died she would wander along that same path, and leaning over the awesome gulf would imagine she could see her lover in its misty depths, and that he answered her back when she called to him. Long after she died, the peasants would affirm that they could discern her ghostly form and streaming white hair amidst the spouting foam of the great fall.

Immense walls of granite, which in places overhang and which tower aloft for not far short of 2000 feet, flanked the cataract on either side. It roared through them, plunging down in clouds of spray, which rose up even to the level of the fields above, making the neighbouring fir trees tremble in the wind of their passing. It has been said that the sound the fall emitted consisted of six distinct regular beats followed by a seventh far louder than the rest, and that when the latter was heard the whole fall would seem to rebound up to half its height, as if at that moment the waters had filled up some enormous cavern below which, no longer able to contain them, belched them furiously out again.

One of the best accounts of the falls in their former magnificence is that of Bayard Taylor in *Northern Travel* (1858). "The Riukan," he writes, "lay before us, a miracle of sprayey splendour, an apparition of unearthly loveliness, set in a framework of darkness and terror befitting the jaws of hell. . . . The river first comes into sight, a mass of boiling foam, shooting around the corner of a line of black cliffs which are rent for its passage, curves to the right as it descends, and then drops in a single fall of 500 feet into a hollow cauldron of bare black rock. The water is already foam as it leaps from the summit ; and the successive waves, as they are whirled into the air, and feel the gusts which for ever revolve around the abyss, drop into beaded fringes in falling, and go fluttering down like scarfs of the richest lace. It is not water, but the spirit of water. The bottom is lost in a shifting, snowy film, with starry rays of foam radiating from its heart, below which, as the clouds shift, break momentary gleams of perfect emerald light. What fairy bowers of some Northern Undine are suggested in those sudden flashes of silver and green. . . . I do not think I am extravagant when I say that the Riukan Foss is the most beautiful cataract in the world."

An out-of-date edition of Baedeker's *Guide to Norway* described the Rjukanfoss as consisting of two leaps, an upper one of 65 feet called the Kvernhusfoss, and the lower one of 492 feet. I have previously drawn attention to the fact that the height of a waterfall may be a very elastic term ; and while in the eyes of the tourist it is the scenic or conspicuous and more or less vertical part of the fall that is generally included in any estimate he may make of its height, to an engineer the term comprises that part which lends itself to development for power. This probably accounts for the great variation of the figures which are given for the height of this waterfall, and, indeed, of most other high falls.

NAWAB SALAR JUNG BAHADUR

In a dozen different accounts of the Rjukanfoss I have noted as many different estimates, no two of which agree and which vary from a minimum of 315 feet up to 900. The correct figures as given to me by Mr. S. Mollerud and, as well, by the Norwegian State Railways, are in agreement and are as follows :

Height of the main lower fall . .	344 feet.
Height including the Kvernhusfoss . .	443 feet.
Total "head"	918 feet.

The mean volume is slightly over 1589 cusecs, and the flood discharge may be as much as 6356 cusecs. From the crest of the Kvernhusfoss to the bottom of the lower fall the horizontal distance over which the descent of 443 feet occurs is about 107 yards.

I did not care to visit the Rjukanfoss in its now depleted condition, and am not, therefore, personally able to compare its surroundings with those of the Vöringfoss which are considered by many to be even wilder and of a more savage grandeur, a fact which I can well believe. Here the Bjoreia River plunges down into a tremendous fissure, whose sheer precipices rise up from 400 to 500 feet above the crest of the main leap. It has been compared to an immense dent in the cliffs which seem to have been rent asunder by the blow of some giant hand.

To-day, thanks to the wonderful road which winds and zig-zags up from Eidfjord to Fossli, passing *en route* through two tunnels hewn in the solid rock, these falls are perhaps more easily accessible than any in Norway. It was amusing, however, to watch the hordes of tourists who on alighting from their motor cars and chars-à-bancs on reaching the Fossli Hotel, rushed down to one of the rocky railed-off platforms on the further side of the chasm opposite the fall, spent perhaps a quarter of an hour or so looking down upon it, and then came away imagining they had "done" the Voringfoss.

It is not from this particular view-point alone, comprehensive as it is as a whole, or by any such cursory inspection, that one can obtain any adequate idea of what is perhaps the most imposing, though scarcely the most beautiful, of the waterfalls of Norway. From the platforms in question, which are, I should judge, almost 400 feet above the brink of the cataract, it is impossible to derive any notion of the correct height of the Bjoreia's great leap, or of the real width or volume of the fall. It deserves and will repay a much more detailed study.

After forming several cascades in its descent from the upper moorlands, the Bjoreia is joined, perhaps a mile or more above the Vöringfoss, by the Isdela River which considerably augments its volume and itself pours into it in a fine cascade, at a reverse angle, at a point where it is bridged by the road leading to Haugastöl. At the junction of the two streams there is a deep blue pool, emerging from which their united waters come surging and twisting at great speed down to the lower bridge where the road up from Eidfjord crosses the river a little before the turn to the Fossli Hotel. It is at this latter bridge that the real descent of the Vöringfoss begins, the total drop from this point to the bottom of the abyss being 626 feet over a horizontal distance of about 306 yards. It may here be added that the main leap is 529 feet, of which about 197 is absolutely "in the clear," though to an uninstructed eye the whole of it would appear to be so.

The bluish-white waters shoot under the bridge with impressive velocity and depth over a low cascade, then, a little lower down, plunge down in a considerable broad and slanting fall over massive ledges of rock into an immense hollow which the river has here eroded between its banks. To get a good view of this upper fall, which is itself impressive, one should follow the short cut to the Fossli Hotel which turns away to the left of that side of the bridge. From this great kieve, if one may so term it, which forms a sort of ante-chamber to the main leap, the waters escape through a narrow rock-hewn chasm to the right of it. Plunging down through this in slanting cataracts, the river takes a sharp left-hand turn at its exit, boils between a mass of enormous boulders and then topples over into the abyss.

A short detour from the path I have mentioned, which leads steeply upwards to the hotel, will bring one to a point whence one can look directly down on the crest of the fall from behind it, and one perceives at once that it is far wider than one would suspect had one seen it merely from the view-point of the average tourist above referred to. From this point, also, can best be seen in their full extent the two minor and very slender cascades which pour down over the great rampart of cliff facing the Vöringfoss, and which drop perhaps 1000 feet, if not more; the one is a straight thin rill, the other zig-zags down in slightly greater volume from a hidden crevice in the cliff.

The rocks at the brink of the great fall divide it, at normal flow, into four separate columns. Of these the left-hand three, facing downstream, immediately converge into an immense volute of white comet-like foam, while the extreme right-hand column forms yet another volute separated from the other from apex to base by a thin dark indigo line. They plunge almost sheer into the seething cauldron far below, sending out coruscations of mist and spray, and from this cauldron the river escapes at a right-angle to the left and goes cascading in serpentine windings down the tremendous ravine in the direction of Eidfjord. Sometimes, and especially in the early morning, I have observed the spray-clouds rising like steam to the very summit of the 1000-foot-high cliffs above the fall.

But to be appreciated in its entirety the Voringfoss should also be viewed from below, and the right time thus to see it is when the rays of the afternoon sun penetrate down into the ravine. One has to go down almost to the foot of the long winding road towards Eidfjord before one comes to the point where the path turns off that leads to the base of the fall, and it is no doubt the thought of the long climb back again that deters many from making the effort. It is, however, well worth it. In former years this path did not exist, nor, of course, was there any bridge over the river above the fall, so that old-time visitors who viewed it even from above, and from the left-hand bank of the river, had to lie on their stomachs and thrust their heads well out over the abyss to get any good sight of it. One of them, indeed, thus described the fall as giving the odd impression of disappearing entirely into space, leaving no other trace than a light cloud behind it.

The rough footpath to its base descends from the road sharply to the river's edge, and after following it up the left bank for a little distance, crosses it by a wooden bridge and then continues along the right bank to a point almost opposite the fall and about 50 feet above the river. It is here that the full magnificence of the cataract reveals itself. I sat for an hour and more at this spot, watching the dazzlingly white plumes and rockets of descending foam burst and shatter themselves, ever to be reborn, as they hurtled into the abyss. The colours of the rainbows, edged at times with living fire, were indescribably beautiful.

The late Mr. W. C. Slingsby in his delightful book, *Norway the Northern Playground*, who saw the falls from this point, has described one of the latter as "a rain ring, an ovoid band of colours—in fact, a complete annular iris, the colours of which were perfectly distinct down to our feet. Not only was there this rain ring, but there was a secondary iris with a reversed order of colours which were quite visible on our right hand down to our feet, where they were mingled with those of the primary rain ring."

Those that I myself saw were scarcely less remarkable. The same writer mentions that in the winter of 1828 the Reverend R. Everest, who then saw the fall, found it "enclosed in a case of ice and surrounded with a framework of icicles reaching from the top to the bottom."

As regards its volume, the Vöringfoss, like most Norwegian falls, has great variation. Its low-water flow may sink to about 424 cusecs, but in flood it may attain to close on 7063. The "head," from an engineering point of view, is about 2165 feet, but, as far as I could gather, no idea is at present being entertained of harnessing it for electrical power.

One wishes one could say the same as regards the Skjaeggedalsfoss which, though of certainly less average volume, is decidedly the more beautiful of the two. It was indeed stated a few years since, in a book on Norway whose title and author I do not at the moment recall, that this fall had been acquired by the Norwegian Tourist Association with a view to its permanent preservation. As I learnt, however, while in Tyssedal, it has now been resold to some Power Company, and it is merely a question of time and better industrial conditions before it and its near neighbour, the Tyssestrengene, will have their waters so depleted as no longer to be worth seeing except in times of exceptional flood. I have, as a matter of fact, seen the engineer's plans for the scheme in question, to which I shall again refer later.

It is Tyssedal which is the starting-place for a visit to the Skjaeggedalsfoss. Here the Tysso River comes cascading down from the Ringdalsvann into the Sörfjord branch of the Hardanger, forming a series of impressive rapids and cataracts, culminating, just before its exit into the fjord, in the imposing Sjoafoss. At the point where it leaves the Ringdalsvann, which is from an hour to an hour and a half's walk upstream, the river is harnessed to supply power for the aluminium works at Tyssedal, and its bed is, therefore, usually dry except after the melting of the snows.

I was fortunate, however, in having timed my visit at about that period, and what had been an almost waterless channel a day or two earlier was now filled with a raging torrent which contributed to make the Sjoafoss a really fine spectacle with an impressive volume. The best and most picturesque way to proceed to the Ringdalsvann, across which one has to take a motor-boat to see the Skjaeggedalsfoss at its further end, is not to take the new road, but to follow the old bridle path up the left-hand bank of the river. This path wends upwards through delightful sylvan scenery, with the river foaming and tumbling on one's left all the way along through and over huge rocks and ledges. At one point it almost disappears in a tremendously deep and narrow chasm, known as the Rjukande, through which it leaps in a series of cataracts, but of whose awe-inspiring depths only partial glimpses are obtainable.

After about an hour's walk one crosses the river over a wooden bridge and comes out on the road which proceeds along its right bank. Presently we note the pretty and slanting Maagelifoss coming down on our left, and a little further on we catch sight of the great dam at the Tyssedal end of the Ringdalsvann which has raised the waters of the lake approximately 100 feet and is nearly 570 yards in length. At its further end the river roars down in a broad and imposing cataract.

Most people appear to have seen the Ringdalsvann, which, by the way, is a little over 1500 feet above sea-level, on a sunless day, as it is almost invariably described as "gloomy," and it upheld its reputation on the occasion of my own visit. But as a matter of fact cloudy skies seem to accord most fittingly with the grim grandeur of the precipitous heights which encircle it, if indeed they do not enhance this effect. The lake is over 300 feet deep and nearly 5 miles in length.

As we glide over its still and placid surface, there is at first no sign either of Tyssestrengene or of Skjaeggedalsfoss. Right ahead of us, indeed, rises aloft a tremendous stark bastion of bare cliff, some 1050 feet in height, which seems to bar the way to further progress. Then, as we round a low projecting wooded cape on our right, the lake takes a sudden turn in that direction, and there at its extreme end plunging down at right angles to us over a lofty ledge, its base for ever curtained in dense masses of curling and shifting vapour, is the wonder we have come to see, perhaps, with the sole exception of the Vettisfoss, the most beautiful of all the Norwegian falls.

One longed for the effect of some sunlight, but the sky remained leaden. That dull, grey canopy overhead, however, did but serve to increase the impression of solitude and majestic grandeur which the Skjaeggedalsfoss must always convey to all who behold it. Here there was no hotel as at Fossli above the Vöringfoss, no throngs of sightseers or cars or chars-à-bancs; no one save the boatman and myself, and the lonely lake set among its towering ramparts and the white ever-changing loveliness of the great fall leaping from ledge to ledge and assuming a myriad fantastic shapes through the "smoke" that partially veiled it.

The late Paul du Chaillu in his well-known book, *The Land of the Midnight Sun*, has given us one of the best descriptions of this fall, though his estimate of its height is excessive.

"Suddenly," he writes, "the Skjaeggedalsfoss, called the Ringedal . . . with its white column came plunging over the edge into the chasm below in one grand leap of 800 feet. Immediately after taking this leap it struck a ledge of rocks and was sent rebounding into a thousand foaming fragments of dazzling whiteness. The angry, turbulent, chaotic and heavy mass, on its way downward, beat against another ledge, and formed a still thicker and heavier cloud of foam and spray. The body of water precipitated itself with such velocity as to create a powerful current of air, which caused the lighter spray to assume a hundred beautiful fantastic shapes. At one moment it was wreathed into a spiral column—waterspout—coiling and recoiling upon itself, bounding forward, coming back, mounting up, then descending—reascending again, breaking itself, assuming shapes and indescribable formations, and then suddenly pushed downward with great force, where it struck a third ledge, and disappeared in a compact and impenetrable mist, hiding the lower part of the fall. This vast white cloud, constantly replenished from the heights above, was sent forward skimming swiftly through the narrow gorge over the beautiful clear crystal stream, which, after flowing on some two hundred yards, again formed a second fall of about 50 feet, from which the spray ascending to the top of the hills appeared like a thin vapour floating in the air. I had seen hundreds of large and thousands of small falls in Norway; many were much higher, but none had ever impressed me with their beauty like the Ringedal."

The correct height of the Skjaeggedalsfoss is 525 feet, though I am not quite sure whether this measurement was taken before the waters of the Ringdalsvann were raised by the dam or since. When the lake is full, which is by no means always the case, though it was so when I visited it, its rise of approximately 100 feet of course shortens the total drop of the Skjaeggedalsfoss by that amount, so that the lower fall which du Chaillu describes is practically wiped out. The main and most beautiful part, however, still remains, though, alas, probably not for long. The

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THE SKJÆGGEDALSFOSS

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low-water volume, by the way, is about 671 cusecs which may increase to a maximum of 4414 in flood.

One catches sight of the Tyssestrengene almost at the same time as one first sees its neighbour, after rounding the low promontory above referred to. A thin spray-cloud from a hidden cleft in the cliffs on our left first betrays its whereabouts, and as we come opposite to this opening we see that it expands in the background into an immense circular bay down the sheer back wall, of which the fall plunges in impressive twin columns. The cauldron into which these pour is hidden from our view-point in the boat, but, emerging from it through a tortuous cleft cut in the rock, the stream comes cascading down in a series of low falls into the Ringdalsvann. Though arresting, it has neither the volume nor the beauty of the Skjaeggedalsfoss. My boatman informed me that its height was 210 metres, or about 682 feet, but as I have no official figures for this fall I do not know if his estimate is correct.

To revert for a moment to the scheme which has been outlined for harnessing both these fine falls, it may be explained that the streams which form them are derived from a number of small mountain lakes, such as the Hattesteinvann, the Breiavann, the Jdlekjeivlökjerne and the Övre Tyssevann and others, which are, roughly, from 2500 to 3000 feet above the level of the Ringdalsvann. The idea is to connect the various lakes by a series of tunnels and then to conduct the water to a large power-house which is to be erected on the left bank of the Ringdalsvann, as one looks towards the Skjaeggedalsfoss, at its Tyssedal end. It is obvious that when this scheme comes into being very little water will pass over either fall except during periods of high flood.

One of the first persons to describe the Vettisfoss was Captain J. R. Campbell in *The Alpine Journal* of August, 1870. "This remarkable waterfall," he writes, "is a fall of about 1000 feet, and comes down in one plunge from the top, presenting the appearance of a feathery tail of foam suspended in a wild black framework of crags, more resembling a sharply cut *bay* than a cleft in the mountain-side." This fall was formerly known as the Morkfoss, and the point of departure for visitors to it is Aardal on the Sognefjord. From there one takes a motor-boat across a lake about 8 miles or so in length to Farnes at its farther end, and from Farnes to Vetti Farm, where one can obtain excellent quarters, is a further 8 miles. The first 5 miles of this can be negotiated by motor-car along a narrow road leading up the valley of the Utla as far as the point where the pretty Hjellefoss comes pouring down on the right from a great height in a series of steps over a slanting precipice. Thence onwards for the remaining 3 miles one has to walk.

The Utla Valley all the way up is extremely beautiful, with tremendous pine-and-birch-clad heights towering aloft on either side of it. The path, which consists for the most part of a very rough and stony trail, crosses the Utla four times by wooden bridges before one arrives at Vetti, and after the second bridge another beautiful foss plunges down on the left. The farm, which is most picturesquely situated on the right, high above the blue-white cascading Utla River, in a depression in the mountains, is about 940 feet above sea-level. Down the lofty heights opposite to it on the Utla's right bank three slender cascades, fed from the melting snows, were pouring down in innumerable leaps, streaking the precipice with their white furrows.

From the farm to the foot of the Vettisfoss is no more than from twenty to twenty-five minutes' walk. One first ascends steeply up the slope at the back of the farm, whence one again looks down into and up the Utla Valley. From this point I could see a small stream, perhaps three-quarters of a mile away, cascading into the Utla on its left bank, and though the Vettisfoss itself was still hidden from view I rightly guessed that it was the debouchment of the river that formed it. The path now dived sharply downwards into the valley and presently passed right across the bare face of an immense slope of débris composed of earth and loose rocks, which I imagine must not be particularly safe after heavy rains. Even then small avalanches of dust and pebbles occasionally came rattling down past me as I crossed it. A little farther on one sees high aloft bursting rockets of foam. Then the cliff on one's right opens and we come opposite the sharply cut bay of which Captain Campbell wrote and in full view of the Vettisfoss.

Far aloft it came pouring out in a full snow-white torrent from a hidden cleft in the mighty rampart of cliff, then coruscating into innumerable rockets of foam, which faded away into the smoke-wreaths ever to be reborn, it hurtled down, down, in one tremendous leap, turning and writhing into clouds of ashen vapour as it neared the foot of the precipice, where a buttress of outward slanting rock at length broke the sheerness of its descent. Down over this it hissed and glided in faery mists, pearl-white against the blackness of the rocks, into a hidden cauldron whence it made a narrow exit to the left. Then broadening out over a wide bed of boulders and split up into several channels, it continued in a slanting descent, finally narrowing through a short rock-hewn channel as it fell in a low and final cascade into the Utla, which here itself comes roaring down between enormous boulders.

Though the stream is but of comparatively small volume, being indeed little more than a mountain beck, and scarcely 4 yards wide at its low stage a little above the point where it plunges over the precipice, I am inclined to agree with the late Mr. Slingsby, who wrote of this fall : " I am not sure whether, taking all in all, it is not the most beautiful in Norway."

When I saw it, the stream was fairly full, though far below its maximum, which may attain to a little over 700 cusecs. Its total drop over a horizontal distance of some 541 yards is about 1202 feet, of which the main leap in the clear is 845. To reach the top of the fall is a much more arduous business, as it involves a very steep and long ascent up a path which zig-zags up the precipice behind Vetti Farm to a height of perhaps 1500 feet or more without a break. Arrived at the summit, one descends through the remains of an ancient forest, crosses the stream, and finally reaches a wooden platform directly opposite the crest of the fall and looking sheer down into the abyss. It is a sight, however, which well repays the effort of the climb up.

Mr. Slingsby mentions a timber-shoot hereabouts down which the peasants used to cast large pines in the winter into the chasm to save themselves the trouble of hauling them down the mountain-side. Many of them, he records, were splintered and broken after their eight-seconds' descent to the ground below, which is scarcely surprising. I did not myself see this shoot, which, for all I know, may still exist, and as I wished to press on to Skogadalsboen in time for the " middag," I had no time to spare to look for it. We are here, of course, on the enchanted ground of the Jotunheim, which of old was reputed to be the home of the Giants, or Frost Kings, who, on account of their malice and evil interference at the time that the human race was created by the Aesir, were banished to these wild mountains by the latter, to live henceforth in the outer cold and darkness, and were forbidden to enter the protecting walls of Midgaard.

Mr. Slingsby's account of the Vettisfoss in its winter garb, when the Jotuns would seem to be still at their magical work, will give some idea of its loveliness at that season. He describes it as " A colossal pillar of ice from the bottom of the foss to the top. This has millions of ice-jewels hanging in festoons from it, from the size of a finger of ice to grand fluted stalactites 150 feet long, and each fluting is fringed with lovely ice embroidery. The colouring is of all shades of blue to purest pearly white as the colours visible in a large crevasse. To the left of the fall a series of gilded icicles nearly 100 feet in height hang from the lip of the rock, the results of peaty water which has trickled over the edge and then frozen. . . . The whole scene is grand beyond description."

To describe all the innumerable waterfalls of Norway, or even those which I myself have seen, would alone occupy the pages of a considerable volume. Perhaps the most impressive falls apart from those I have already described are the twin leaps of the Laatefoss and Skarsfoss, some 9 to 10 miles from Odda up the Opa Valley. On the road up to them one passes three other fine falls, namely, the Eidefoss on the left and the Jordalsfoss and the Hildalsfoss on the right. Neither of these has any very imposing volume, but of the three I think I was most impressed by the Eidefoss on account of its great height. Long before one gets to it one can see part of this fall plunging down into the valley, but it is not until one comes opposite to it, or rather, a little way past it, that one perceives that what one had taken to be its summit is far below the real crest. A workman on the road by the bridge below informed me that the fall dropped 700 metres, or not far short of 2300 feet, in all ; and as far as I could judge his estimate did not seem to be excessive. I have seen other waterfalls in Norway fully as high, though, like the Eidefoss, they were broken up in a series of leaps and none dropped " in the clear " for anything like that distance.

The crests of the Laatefoss and the Skarsfoss, both of which are fed by streams that emerge on the extreme right and left sides of the same lake, are about 541 feet above the roadway which bridges their base, and are separated by a rampart of cliff of considerable width. They come plunging down in several leaps, the upper of which converge towards each other, though they do not mingle, while the lower ones again diverge farther apart, being separated by an immense mass of rock in the centre. It is at the base of this rock that the two branches finally meet and go swirling under the road bridge into the Opa River.

As one faces the falls, the Laatefoss is on the left and the Skarsfoss on the right. The upper leap of the former, plunging into a hidden rock basin in a dense column and sending showers of spray whizzing upwards, and the lower leap of the latter are the most impressive. The volume seems greater than it actually is, the low water flow being no more than 282 cusecs, rising to 3531 in flood. So far these falls have escaped spoliation, though I am told the question of harnessing them has been under discussion. A little farther up the road on the opposite side the pretty Espelandsfoss falls down into the Opa, but it is not nearly as impressive as its near neighbours. Its height is approximately 335 feet.

Other noteworthy Norwegian waterfalls, which I can but mention here, are the Tinfoss and Sagfoss, and the Skykjefoss and Rembesdalsfoss. The two first mentioned mingle their waters in one fall. They are no more than about 50 feet in height, as far as the main drop is concerned, with a "head" of about 91. Their volume, however, is considerable, varying from 2542 cusecs to not far short of 16,000 in flood. These falls have been harnessed to the extent of 23,700 kilowatts.

The Skykjefoss, which I saw only at a distance, has a main leap of 820 feet with a "head" of 2625 feet, but the discharge is comparatively small, being no more, even at high water, than about 1412 cusecs. The Rembesdalsfoss, one of the most picturesque falls in Norway, has a clear leap of about 984 feet, with a "head" of the same amount as the Skykjefoss. Its flow may dwindle to less than 106 cusecs at dead low water, increasing to nearly 2300 in flood.

The Rjoandefoss in the famous Flam Valley is another extremely graceful fall, which, though of slender volume, drops 455 feet; while the famous Syv Sostre or Seven Sisters on the Geiranger fjord will, of course, be familiar to thousands of tourists; but it is only when full that they number more than four separate falls. Lastly I may mention the Keelfoss, or Kilefoss, on the Naerofjord. I have no statistics of this slender but lofty fall, which I note some writers have asserted to be one of the highest in the world. I have seen it stated that the actual "head" of it is 4200 feet above the fjord, with a first sheer leap of over 800 feet; but I cannot vouch for the correctness of the figures. Personally it did not impress me in comparison with many others that I saw.

CHAPTER XXII

THE NOTABLE WATERFALLS OF SWEDEN

WHILE, owing to the abrupt descent of the mountain plateaux on their western sides, the majority of the Norwegian rivers come down over steep and turbulent courses and are largely of the nature of mountain torrents, the declivity on the eastern or Swedish side of the Scandinavian ranges is, generally speaking, less steep, so that the streams in many places expand into lakes connected with each other by rapids and falls, and it is between these that we often find the finest cataracts. These lakes are largely due to the enormous pressure of the ice in the glacial period, and it was also then, or later, that many of the Swedish valleys became filled with sediment, which blocked up the original courses of the rivers, causing them to change their directions and to carve out other channels. It is due to this fact that many of the waterfalls have been formed.

As regards the Lulea River, for example, there is little doubt but that the water from the great Lulea Lake, or the Stora Lule Träsk, once started from Luleluspen to Rånealv in a south-easternly direction, but it later forced its way south over the Porjus and Harsprånget Falls to what is now the Lulea River, and in this way carved out the valley which now extends below the lake's south-east extremity.

In the upper or mountainous parts of their courses, the variation in flow of the Swedish rivers may be very marked, the high water volume being anything from thirty to eighty times that of the minimum discharge ; but in their lower courses the lakes I have mentioned act to a great extent as regulating reservoirs, and therefore counterbalance in some degree the sudden rises which occur during the spring floods after the melting of the snows.

It has been calculated that about one-eighth of the whole area of Sweden consists of water either in the form of rivers or lakes. Of the total water-power of the country which, as we have noted, is reckoned by Lieutenant Serrander to amount to 6·2 million h.p., as available for nine months in the year, by far the greater amount is in the northern districts. Thus, he estimates that Lower Norrland and Delarne possess 2,560,000 and Upper Norrland 2,410,000. It is not surprising, therefore, that with the main exception of Trollhättan, which with Älvkarleby is the most important source of power in the south, we find the chief waterfalls to be situated in the northern regions. It is on the Lulea River that three of the finest of the falls occur, and all three of them are situated within the Arctic Circle. For the statistics regarding these and other Swedish waterfalls I am much indebted to Mr. J. Plass, of the Swedish Royal Board of Waterfalls.

The first of these falls, taking them in order downstream, is the Stora Sjöfallet where the Lulea makes its descent from the lake of Kartjejaure to that of the Langasjaure. This region, once so remote, has now been set aside as a National Park, for which the same kind of restrictions are in force as apply to the Yellowstone or Yosemite Parks in the U.S.A.; consequently these magnificent falls are henceforth exempt from spoliation. The total descent from the upper to the lower lake is about 132 feet, over which the river plunges in a series of falls, making, broadly speaking, a double leap, somewhat recalling that of the Iguazu, though differing widely from it. The cataract is divided into several distinct channels by a series of rocky islets, and is far wider at its base than at its crest.

There are two main upper falls separated by a mass of rock, namely, that known as the Hermelins Fall on the right side, looking downstream, and the Laestadius Fall on the left, so named after Baron Hermelins and Peter Laestadius, a missionary. Their total width at the crest where they leave Lake Kartjejaure, and including the dividing islet, is about 220 yards. The second leap is split up by two fairly large rock masses and various scattered smaller ones, the chief falls from right to left being the von Dubens Fall, Petterssons Fall and the Wildmarks Fall. The crest of this second descent, including the islets, is not far short of 600 yards. At the base of the cataract where it plunges into Lake Langasjaure the width increases to over 900 yards. These figures are approximate and are calculated from a map of the falls, scale 1:10000, kindly sent to me by Mr. Plass.

The low-water volume, after regulation, is 1165 cusecs, but the normal high-water flow is 26,486 cusecs, which may increase to a maximum of 38,034. Thus, at the latter period, the discharge is but slightly less than the mean annual flow at the Victoria Falls. The accompanying views were taken at comparatively low water, and much of the bare cliff here shown is covered when the river is in spate. To-day all this region of falls can easily be reached by trains *de luxe*, for the greater part of the way at least, from Stockholm in little more than forty-eight hours, and for a short period of the year Stora Sjöfallet, the Harsprånget and the Porjus Cataracts, though the latter are harnessed, bid fair to become popular centres for tourists.

Set as they are amidst the surrounding mountains, the falls of Stora Sjöfallet are always impressive in their lonely grandeur, and when in high flood present an awe-inspiring and magnificent spectacle. "Here," writes Mr. Steveni, "you have come to the heart of the mountain world, to the real wilderness, far away from inhabited country. This remarkable cataract, with its roaring masses of water, looks at a distance like a gigantic snowdrift. It has, so far, escaped the work of demolition, and, standing close by this gigantic, boiling cauldron, you cannot but realise the littleness of man before the silent, untouched grandeur of nature."

The Porjus Cataracts lower down the river and just below the outlet of the Stora Lule Träsk occur between 125 and 150 miles above the Lulea's mouth. The region through which the river here flows consists of the lower part of the Norrland lake district, and for miles around is interspersed with bogs and morasses and lakes, some of which are of a considerable depth. The great Lulea Lake itself is several miles long, and varies in width from a mile and a quarter to well over three miles near the island of Stuorsuolo, which itself is nearly two miles long. Its greatest depth is close on 92 feet.

The average height of the surrounding hills is nearly 1500 feet above sea-level, the highest point, Mount Apakes, attaining to over 2571. It is within a narrow gorge after leaving Porjusselet Lake, just below the Stora Lule Träsk, that the Porjus Falls occur. These falls, which are preceded by the Luspenforsana Fall, which drops about 28 feet over a distance of some 2¼ miles, consist of four separate cataracts which aggregate nearly 166 feet in height and which are separated by a series of small pools. They extend over a distance of more than 1¼ miles. The main drop is that known as the Ruoutekårtje, the second in order from the top which descends for 88 feet. The bed of the river and the banks are mostly of red granite mingled with iron ore.

Before approaching the main leap the river flows among a number of variously sized islands, of which the largest is just above the Ruoutekårtje Fall. Below the four falls which make up the Porjus Cataracts there are two further cataracts, namely, that of Lillselsforsen, over 200 yards further down, which drops about 20 feet, and Långelsforsen with a descent of close on 50 feet. The

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[illegible] THE UPPER FALLS [illegible] THE RHINE FALLS [illegible]

first of these extends over a distance of more than 700 yards, and the second over about 1¼ miles.

As will be gathered, this series of falls is rather of the nature of a succession of steep cataracts, much like the upper cascades of Paulo Affonso on a smaller scale, than any sheer and high vertical leaps. The aggregate height of the whole series of falls, however, including those in addition to the four Porjus Falls, is about 266 feet, and the volume of water varies from 1095 cusecs in the dry season to as much as a maximum of over 52,972. The mean flow covering the period from 1910–1915 has been found to be over 8934 cusecs.

The Porjus Falls have been long harnessed by the State and the machinery installed can furnish 50,000 h.p. Part of this supplies power for the State electric railway from Kiruna to Riksgransen, and part supplies the mines at Gallivare and Kiruna. Electric light is also supplied to most of the outlying villages where it is especially welcome in view of the long periods of winter darkness in those latitudes. In addition to using the power from the Porjus Falls the plant also utilises the water from the large Lulea Lake and from the Porjusselet Lake. This scheme involved the building of a dam at the outlet of the latter, which has a length of over 1370 yards, with a height of nearly 40 feet above water level and is the largest dam in Scandinavia.

Some 8 miles below the Porjus Cataracts we come to the third and greatest of the falls on the Lulea River, the famous Harspranget, or Hare's Leap, which is considered by many to be the finest and greatest waterfall in Europe. It is also called by the Lapps the Njommelsaskas. The Lulea here descends over a series of boiling cataracts, dropping 243 feet in a distance of 2¼ miles. Detailed accounts of these falls are scarce. It has been stated by many writers that the highest of the various leaps is from about 89 to over 100 feet, but I am informed by Mr. Plass that there is nowhere any sheer vertical drop, and that the whole of the descent consists of sloping, though tremendous, cataracts and rapids. One of the earliest allusions to these falls occurs in John Scheffer's *History of Lapland*, in which he refers to "the third" (fall) "call'd Niomesaski, or the Hare's Leap, because the River Luhlao forces its way through so narrow a passage between two rocks that a hare may leap from one to the other." Mr. Steveni, in his *Unknown Sweden*, apparently quoting some old and inaccurate account, writes :

"At the termination of this series of lakes a fall occurs which was considered by one authority to be the largest in Europe. One stream then forces its way through a narrow mountain cleft, another dashes into a deep dell; here it is opposed by a rock which breaks it and throws up a torrent several fathoms high into the air. The entire length of the fall is one-eighth of a mile, and its height is about 400 feet; its thunders can be heard some miles off. The ascending vapours freeze in the winter, and form a wonderful arch of ice; the name given to this remarkable fall, Harspränget (Hare's Leap), signifies that hares could traverse the ice-bridge over the flood—a metaphor suitable for poetic natures."

For the partial view here given I am indebted to Svenska Föreningen, Stockholm. Steveni himself gives 245 feet for the total height on a length of nearly 2 miles, and he adds that the beauty of the spot in time will be spoiled by the erection of a 130,000 h.p. plant. Nothing, however, has yet been done in the way of harnessing these falls, and the correct figures are those I have quoted above on the authority of the Swedish Royal Board of Waterfalls.

Below the Harspränget, there are a number of minor falls which extend over various horizontal distances, namely the Lakkoforsana about 31 feet in height; the Krokselsforsen, 36 feet; the Bredselsforsen, 8 feet; the Liggakártje, 57 feet; the Liggakuoika, 41 feet; the Njuoravuollekuoika, 38 feet; the Tuorakuoika, over 115 feet; and the Kaskajerimkuioka, about 60 feet. In short the total drop of the river over a distance of some 25 miles, that is to say between its 100th and 125th mile reckoning upwards from its mouth, is some 646 feet.

At the Harspränget itself the available "head" is over 350 feet. Taking the mean of the years 1922 to 1932, the normal minimum volume is close on 1448 cusecs, and the normal high-water volume, nearly 38,352. The maximum discharge will attain to over 53,673 cusecs, and appears to be exceeded alone among European falls by that of the Sarpsfoss, and the much lower falls at Älvkarleby on the Dal River; though it is quite possible that the extreme flow of Dettisfoss in Iceland, for which I have no figures, may also exceed it.

The area in which the falls occur is a desolate and very sparsely inhabited region, full of bogs and morasses as in the case of the surroundings of Porjus, a few miles higher up. But the valley of the Lulea itself is here both deep and narrow, and is here and there intersected by deep ravines, through one of which, over 328 feet

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in depth, one of the great river's tributaries, the Muddusjokk, joins it. Still grander is the gorge of the Turakärso, and that of the Nietsakårso. The rocks of the river-bed and its banks are chiefly red granite.

The falls of Älvkarleby on the Dal River, to which allusion has just been made, have now for some time been harnessed by the State. They are of no great height, not indeed much exceeding 26 feet, though the available "head" is about 69 feet. It is their volume which makes them formidable as the accompanying photograph, taken before they were developed, indicates. The immense rush of torn and twisted water here shown is somewhat reminiscent of the upper cascades, again, of Paulo Affonso. The maximum flow here may be close on 74,161 cusecs, which considerably exceeds the mean discharge at the Iguazu Falls, and is not very far short of the *average* flood volume of the Zambesi Falls. The mean water flow is about 12,359 cusecs, but the minimum, since regulation, may be no more than 2825.

The power station was commenced in 1911 and completed for service in 1915. It involved the construction of a dam over 760 yards in length.

The Rista Falls on the Undersåker River between Ostersund and the frontier, and those of Tannforsen which drop between 90 and 100 feet are other noteworthy Swedish falls. The latter is divided by a rock called the Bear Rock, on account of the fact that a bear was once drowned here while attempting to swim across the river. One may also mention the Storbo and the Handol Falls. But probably the best known of all the waterfalls in Sweden are those of Trollhättan on the Gota River.

Lake Vanern, of which the Gota is the outlet, has a drainage area at that point of over 18,000 square miles, that of the actual lake being 2142. It provides a notable instance of the way in which the Swedish lakes act as regulating reservoirs, as the Gota's variation in flow is much less marked than in the case of many other Swedish rivers. The minimum volume at the falls is about 10,418 cusecs; the mean, 17,657; and the flood flow, 29,311 cusecs. The total "head" is just under 115 feet. The falls have, of course, long been harnessed; the available horse-power being 190,000 of which 127,000 kilowatts is utilised.

The Trollhättan Falls are really a series of boiling cataracts which are spread over a distance of about a mile between stark, rocky cliffs. Mr. W. W. Thomas, a former United States Minister to Sweden, who saw the falls prior to 1893, wrote: "The waters come roaring from the rapids above and plunge down a steep incline of 42 feet. The great boiling mass struck some boulder at the bottom and was tossed aloft in slant, foaming jets, each one seeming to leap higher than its predecessor, and spread out splayey wings as it fell over its fallen comrades. We lingered directly over this fall, leaning upon the iron rail of a little gallery which trembled with the shock of the waters." This fall he describes was the second from the top and the finest, which is known as the Toppo Fall. A. F. Skjöldebrand wrote an account of it in French in 1804, of which I give the following translation:

"The river, divided into two by a barren and hollow rock, shoots out with fury and falls over a frightful precipice. On this side of the rock the waters being closely confined are raised up at the sides and depressed in the centre, where they seem to wrestle together for their passage. Finding nothing yet to obstruct them, the surface is almost unbroken and of a transparent green, mingled with threads of foam; but presently, impinging on the uneven rocks, their whole mass seems like an immense avalanche of snow, where in constant movement the most exquisite transformations appear and disappear in the twinkling of an eye. The immense quantity of the water which is precipitated in a passage so narrow and with inconceivable velocity, the height of the rocks which compose the banks against which the river hurls itself and which threaten to crumble at the terrible force which shakes their foundations, a noise comparable to that of a hundred thunder-claps combined—all this it is which makes the spectacle so arresting and so worthy of attention."

The first fall is also divided by a rocky islet, one branch of it having the name of Güllo and the other that of Nolstrom. The third fall is known as Tjuffallet, or the Thieves' Fall, regarding which the following legend is recorded. It is said that in one of the cliffs by the side of this fall there was a cavern which certain robbers used as their den and hiding-place for some seven years.

One day they captured and carried off to this place the daughter of a woodcutter, who, after some time, persuaded the chief of the bandits to let her return home to join her family for the Yuletide feast. This request he acceded to, but first made the girl swear a solemn oath to return again and on no account to reveal their hiding-place. She kept her oath, but on leaving her family after spending some hours with them, she carried off with her a truss of straw from her bedding, the old Swedish custom being that every Christmas Eve each family had to strew the kitchen floor with straw upon which the servant girls and farm-labourers, etc., were used to lie down and pass the night together ; a superstition said to originate from the fact that Christ was born in a manger. On her way back to the cavern, the girl scattered this straw, thus leaving an easy trail ; and the following morning the cave was surrounded by the peasants, who captured all the thieves except a few who cast themselves into the abyss of Trollhättan.

Skjöldebrand says that in his time there was no trace of this cave ; but Olaus Magnus writes : "The common name is Trolhetta, that is the Devil's Coul ; it may be by reason of the noyse and sound it makes when it falls into a laky plain, or because under the headlong descent of it, there is found a most notable den of thieves."

Du Chaillu also says that the name Trollhättan signifies "Witches Caps," but Verelius, the commentator on the Hervarar Saga says that in the ancient Gothic tongue the word hätta signified a perilous enterprise, or some danger, meaning that the passage of the cataracts was dangerous even to Demons ; though others assert that it was the presence of the robbers that had their lair there that rendered the locality dangerous.

According to the Hervarar Saga, mentioned above, the falls have been known from remote antiquity, for here, it is said, there took place, long before Odin arrived in the north, the terrific combat between Starkadr, a four-armed giant, and the renowned warrior, Hergrim, who during Starkadr's absence had stolen away his fiancée, one Ogn, a daughter of the Elves, and had married her. This combat resulted in the death of Hergrim, whereupon Ogn, who had watched the fight, promptly slew herself.

Since that time it is asserted that the falls of Trollhättan have been the scene of numerous combats. Here, too, it is recorded that aged and wearied Skalds, after singing their last lays to the accompaniment of their harps, would cast themselves into the falls, beneath which they henceforth dwelt as youthful River Sprites, whose music could be heard on moonlit nights above the roar of the cataract. Above the fall of Toppo is, or was, a seat known as the Kungssoffan because so many kings had sat on it.

The fourth fall is called the Helvetes or Hell's Fall, and the last is merely a low cascade near Flottbergsströmmen. To-day, of course, this famous cataract can scarcely be said to exist any longer, so depleted have its waters become on account of their diversion to supply power for rolling-mills, machine shops, foundries and cellulose factories, etc., etc.

CHAPTER XXIII

THE WATERFALLS OF CENTRAL AND SOUTHERN EUROPE AND OF THE BRITISH ISLES

AS far as the rest of Europe is concerned apart from Scandinavia, there are but few really imposing waterfalls with the exception of the Rhine falls and nothing, generally speaking, which can compare with the majority of the northern falls that we have discussed in the two preceding chapters. I have already quoted Lieutenant Serrander's figure for the water-power of Switzerland as being 1·5 million h.p. It may be of interest to give here those he has calculated for some of the other European countries on the same basis; that is for nine months in the year. Of these Austria has the greatest amount, namely 6·1 million h.p. France is next with 5·9 millions. Then follows Italy with 5·6, and considerably lower down we have Germany with 1·4 and Great Britain with 1 million h.p.

The greatest falls in Central Europe, as far as volume is concerned, are the well-known cataracts on the Rhine near Schaffhausen, which it is almost superfluous to describe. It is scarcely possible in these days to emulate, as far as they are concerned, the eulogies of the learned M. Johannes Herbinius who extolled them in that curious book of his published in 1678 and entitled *Dissertationes de admirandis Mundi Cataractis, Supra et Subterraneis, earumque Principio, Elementorum circulatione, ubi eadem occasione Aestus Maris Reflui, vera ac genuina causa afferitur, etc.*

The Rhine falls are sometimes also called the "Laufen," though, strictly speaking, the latter name really belongs to the series of rapids some distance further down the river. The Rhine here plunges over a ledge of Jura limestone from a height of 67 feet, the width of the crest being a little less than 380 feet. The best view of the falls is from a projecting stage of iron bars known as the Fischetz which has been thrown out from the vertical cliff and overhangs them. Though of no great height, the velocity of the water as it nears its leap, owing to the contraction of the banks, and the roar the falls emit, make them sufficiently imposing. A high pillar of rock splits the cataract into two main sections, and three smaller ones can also be seen projecting above the plunging flood except when the river is high.

It has been stated that in the early spring of 1848, 1858 and 1880 the water was so low that it was possible to cross the river above the falls by leaping from one rock to another. Since the falls have been harnessed they have, of course, lost much of their interest, For the correct figures of the volume I am much indebted to the Director of the Service Fédéral des Eaux, Bern, who tells me that the mean annual volume is 13,066 cusecs, the minimum 3531, and the extreme flood discharge, 38,140 cusecs, though normal high water will amount to 24,720.

In Baedeker's *Switzerland* (1897) the writer remarks: "It is curious that no mention of these falls occurs in history before 960. It has therefore been supposed that they did not exist until about 1000 years ago, and that, while the bed of the river below the falls has been hollowed by erosion, the deepening process above the falls has been retarded by the hardness of the rocky barrier above mentioned."

If we include the rapids above the cataract, its total height is probably not far short of 100 feet.

One of the most picturesque and romantically situated falls which, like those on the Rhine, partly belongs to Switzerland, is the Saut du Doubs on the river of that name and in a section of its course where it forms the boundary line between Switzerland and France. Though this river, which is a tributary of the Saône, is some 267 miles in length, less than 60 miles separates its source from its mouth, so circuitous is its course.

The falls which are 89 feet in height occur in a remarkable gorge whose walls, below the leap, rise from 800 to 1000 feet. They are preceded by five remarkable basins, where the deep-green waters of the river open out into circular or elliptical expanses, each of them being connected one with another by narrow channels. In the first basin, surrounded by lofty wooded hills, is the well-known Grotte de Toffière; and on the Swiss side in an angle of the cliff a wonderful echo repeats distinctly anything that is said on the French shore. The second basin is a regular niche surrounded by perpendicular rocks. The level of the flood waters has been marked here on the cliffs, showing rises of 10 feet in 1801 and 8 feet in 1863.

The rocks assume extraordinary fantastic shapes, some of them resembling human beings. One of them, for example, bears a likeness to Louis Philippe on one side and to Napoleon I on the other. The third basin, also encircled with rocks, is oval in shape. The fourth has on the Swiss side a large undulating grass-plot called the Pré Philibert. Here in July the French and Swiss *Riveraines* dine in the open air on the day of the Fête du Saut-du-Doubs, which recalls the Fête des Loges de Saint-Germain-en-Laye.

On the left a towering pinnacle depicts the Virgin holding the infant Jesus on her arm. It is from the fifth basin, which is quadrilateral in shape, that one lands and takes the path to the falls. They are best viewed from a little rocky promontory which partly overhangs them. The water shoots out in a splendid curve, sending up clouds of foam and transparent spray from the deep pool below, beyond which the narrow gorge winds away at the foot of the mountains. So great is the velocity of the plunging torrent that, as we have already noted in the immensely greater example of Paulo Affonso, a stone hurled against it rebounds back as if repelled by some magical armour.

At comparatively low water a number of rocky islets seem to threaten to dam back the water at the edge of the precipice, but these are all entirely submerged when the river is high, at which time its volume is very considerable. It is said that nothing which falls into the pool ever comes again to the surface, and according to legend the falls have been the scene of a good many tragedies. Numerous factories and saw-mills on the banks of the lower gorge largely detract, unfortunately, from the beauty of its surroundings. At the foot of the fall in flood time, the plunging mass has been described by a French writer as falling " avec un bruit de tonnerre si formidable que le sol tremble comme sous un effort souterrain."

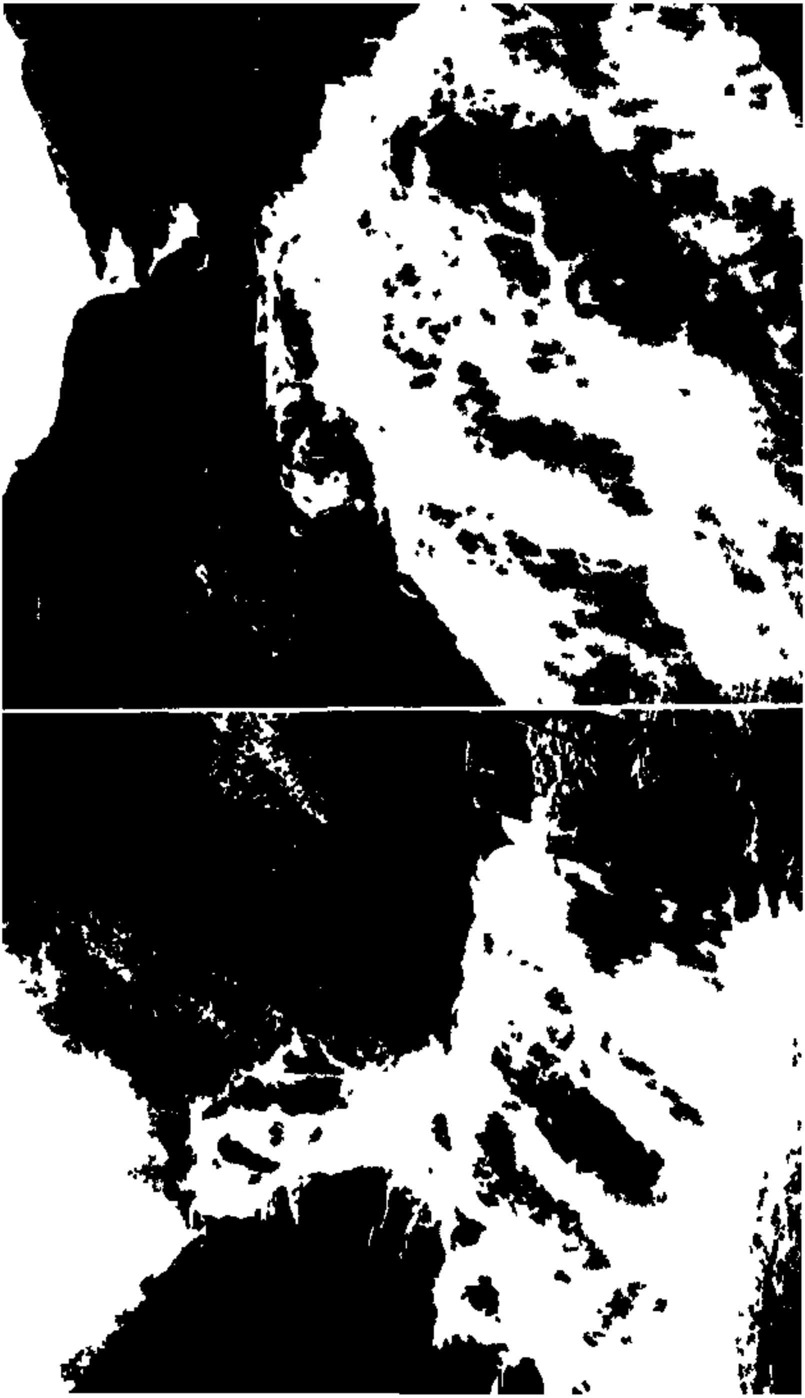
It is impossible here, nor would it be pertinent, to mention more than a few of the hundreds of waterfalls in Switzerland, but few of which have any imposing volume. Generally speaking, they are pretty rather than impressive. Among the more outstanding cascades are the Reichenbach, the well-known falls on the Aar, usually known as the Handeck Falls, the Pissevache on the Wildbach Salanfe, the Staubbach, the Trummelbach, the Tosa, the Giessbach and the Staubi or Staubibach.

The Reichenbach, which is one of the best known of all the Swiss falls, derives its waters from several springs, the most important of which come from the Black Forest and the Black Horn. That of the latter, at the back of the greater Scheidegg and the Nord-Hang of the Wetterhorn, passes over the Breitenboden Alps and forms a beautiful waterfall above Rosenlauibad. It receives the springs which discharge from the Rosenlaui glacier, enters a wooded ravine and plunges down in a series of imposing falls into the Aar below. The total " head," according to the figures given to me by the Service Fédéral des Eaux, is nearly 1966 feet, but the main series of leaps appear to aggregate close on 1000 feet. There are seven of these falls, of which the upper one is generally considered to be the finest, and, next to it, the lowest. It was the Reichenbach Falls, by the way, which the late Conan Doyle selected as the scene of the disappearance of Sherlock Holmes after his tussle with the malign Moriarty.

The falls of the Aar, or the Handeck Falls, are situated in the upper Aar valley between Grimsel-hospiz and Guttannen, being about 3¾ miles from the latter place. Here in a narrow ravine the Aar plunges down over a ridge of rock for about 150 feet, mingling its greyish-green waters with those of the white Gischt from the Aerlenbach which here pours in from the west, forming another fall of about the same height. The gloom of this wild gorge and the quantity of water renders this fall one of the most striking in Switzerland. Indeed, the volume of the Aar may be very considerable, and Reclus states that at the point where it joins the Rhine its mean flow is greater than that of the latter by over 3000 cusecs, the proportion being 18,080 cusecs to 15,010.

The Pissevache on the Wildbach Salanfe is considered by many people to be the most beautiful and important waterfall in Switzerland. After passing between the Tety and Mont Byollen, the torrent makes a sudden leap over a high and bare rock wall between the village of Vernayaz and the hamlet of Mieville at the top of the Rhone valley. The drop is about 213 feet. The stream pours out of a narrow ravine and has its sources in the Dent du Midi. The fact, however, that, as in the case of many Swiss waterfalls, it has been harnessed for power, detracts from its former splendour.

The much famed Staubbach in the Lauterbrunnen valley, or "Dust-Stream," Wordsworth's "sky-born waterfall," which Byron, also, compared to the tail of a white horse streaming in the wind, needs no description at this time of day. It is its height, of course, which is approximately 900 feet, which has so long made it noteworthy, but it has so small a volume that it is dispersed by the wind into fine spray before it reaches the floor of the valley. The stream which feeds it is the Pletschenbach which higher up forms another fall out of sight of the valley. In winter it becomes a mass of enormous stalactites of ice and ice grottoes, reminiscent of the frozen Vettisfoss which I have already described. It is when the wind sways the descending column, which has been compared to an immense lace veil, that the Staubbach Fall assumes the most remarkable and lovely shapes in its various and manifold undulations.



[illegible]

THE STAUBBACH, LAUTERBRUNNEN

Height [illegible] feet

The falls of the Trummelbach on the other side of the Lauterbrunnen valley, though not so lofty or graceful, are much more imposing in volume. They are formed by the discharges of the Eiger, Guggi and Giessen glaciers and by the melting snow in the upper Trummletental. They descend through a narrow crevasse in five falls of which the third is the finest, and are impressive on account of the force with which the waters come plunging over the rocks. Like the Pletschenbach, the stream ultimately pours into the Lutschine. They have for some time been harnessed to supply power for the working of the electric railway to Murren, and I am told that electric lifts, artificially cut steps and tunnels have "embellished" their amenities for the benefit of the tripper.

The Tosa Falls, also known as the Cascata della Frua, are on the route from Ulrichen to Domo d'Ossola. Of considerable volume, they descend in three cascades, foaming over a series of steps, and spreading their waters out in the shape of a fan. Their aggregate height is said to be 470 feet on a horizontal distance of over 330 yards. The width of the falls is 85 feet.

The Giessbach, which is fed by a considerable number of small brooks, rises on the north flank of the Schwarzhorn's Blue Glacier. It falls three times over high rock walls, collects from the Tschingelfeldalp the streams coming from the Hexensee and the Hagelsee, and then turns north. Afterwards it drops over a ridge on the Bodenalp, where it receives more small tributaries of which the largest, the Hilfenenbrunnen, also forms a pretty fall. At the lower end of the Bodenalp the Giessbach enters the Bottenklamm between walls of nearly 300 feet in height. At this point it at one time threatened to vanish down a subterranean funnel, but in 1824 the fissure was blocked up by the then Government. Leaving this ravine, it passes through an almost level, wooded valley and then descends over the well-known falls to Lake Brienz in a succession of cascades which are said to aggregate some 1200 to 1300 feet in height. It has been compared to a great staircase of foaming water framed in thick woods of oak on either side. The volume, however, is not great. Three bridges cross the falls, at the highest of which the torrent makes a sheer leap of some 190 feet.

The Staubi or Staubibach Falls, near Unterschachen, are stated to drop about 305 feet, shooting out with great force into the air and producing immense clouds of spray; and lastly one may note the fall of the Modesino on the route from Thusis to

Colico, near the Splugen Pass, which has been extolled by Mr. C. L. Freeston, F.R.G.S., as one of the finest in the Alps, and which, according to one estimate, drops 853 feet, though I do not vouch for the figures. But in truth so many of the Swiss waterfalls, such as the Barberini and others, have now been harnessed and depleted that they have largely lost their former attractions.

Before turning to the regions of the Eastern Alps and Austria, etc., one must note in France the famous Perte du Rhone where the river forms a chute of some 82 feet. I have already alluded to the extraordinary narrows here formed by the Rhone in my account of Paulo Affonso, and to the fact that one of its tributaries, the Malpertuis, has at one point a channel only some 5 to 6 feet in width, but of a depth of about 95 feet. Some years ago this remarkable cañon of the Rhone was threatened with entire extinction by the installations at Bellegarde, which involved a project for creating a barrage some 328 feet in height between that place and Seyssel, the effect of which would be to submerge completely under from over 130 to over 220 feet the whole of the Perte and the cañon ; but I am not aware how the matter now stands, or if the barrage in question was actually erected. It would, at any rate, be a thousand pities if this great natural curiosity were to be thus ruthlessly wiped out.

In the district of Limousin, in central France, there are some noteworthy cascades on the Gimel or Montane River in the Parc Vuillier. There are three chief falls, namely, the Grand Cascade of 137 feet ; La Redole, 88 feet ; and La Gouttatière, or the Horse's Tail, of 81 feet ; to which may be added a lower, but very pretty fall—the Gourg. They all occur in a deep wooded gorge flanked with hawthorns, wild roses, ferns and jonquils, etc. Below the second fall, the Redole, is what is called the Inferno, where the ravine becomes deeper and the cliffs more abrupt, taking on the appearance of porphyry. Below, again, there is a cave in the rocky rampart of the cañon where there lived and died St. Duminie, a warrior of the old days of King Clovis, who became an anchorite and was made a Saint, and about whom several curious legends have been recorded. It is said that an Oratory which he built here became the parish church in the twelfth century and was regarded as the pride of all the countryside.

On one occasion one of the bells of the Oratory is said to have fallen into the torrent and was finally regained with great difficulty. Some women, however, who were helping to haul it up suddenly started to laugh, whereupon the bell fell back again into the stream and was never again redeemed. St. Duminie, it appears, had a grudge against all women on account of the fact that the wife of a poor herdsman had objected to her husband sharing his frugal meals with him, and on being informed of this the Saint declared that no woman should ever enter his chapel or appear before his relics after his death.

Not far away in this same neighbourhood there may also be noted the Saut de la Virolle, near Treignac, on the Vezère, which has a considerable volume when the river is high.

In the Pyrenees there are comparatively few imposing waterfalls. Many of them, moreover, appear to hide their retreats from the visitor, as far, that is, as getting any good and complete view of them is concerned. I remember while staying at Ax-les-Thermes making more than one vain attempt to inspect two different falls in the neighbourhood, whose names I have forgotten, but though both were fairly well visible from the road at a distance, I was quite unable to approach them closely enough to obtain a near view.

The most noted fall in the Pyrenees, on account of its height, is the well-known Cascade de Gavarnie, or the Grande Cascade, in the famous *cirque* of that name, which when swollen by the melting of the snows has a sheer leap in the clear of 1384 feet; though in the dry season the descending column is broken about two-thirds of the way down. Its imposing surroundings make this fall remarkable. The great *cirque* is about 5 miles around from east to west, and at times as many as 13 different falls, though none of them of any great volume, can be seen plunging over its sides from the slopes above which are covered with perpetual snow, and where there are numerous glaciers.

The Grande Cascade is extremely beautiful as it sways and undulates in the wind, much like the Staubbach in the Lauterbrunnen Valley. At the base of the *cirque*, in cutting its way through the masses of snow, the torrent forms numerous snow-bridges.

The cascades of Cerisey and the Pont d'Espagne, both near Cauterets, those of Juzet and Montauban, and the Cascade du Cœur, one of a number of falls near the Vallée du Lys and the Rue d'Enfers, as well as the Gripp waterfalls some 10 miles from Bigorre, are other falls in the Pyrenees which we can only mention here.

In the Eastern Alps, and including the Tyrol, the Bavarian Highlands, Austria, with Styria and Carinthia, etc., there are a great number of waterfalls, the majority of which are less well known to travellers than they ought to be. Among the finest in all this part of Europe are the falls on the Krimmler Ache, near the village of Krimml. This stream, which is the discharge of the Krimml Glacier, descends in three leaps to a total depth of about 1400 feet, the highest fall, which is divided into two separate plunges, being about 460 feet. Various platforms have been constructed at different points of the mountain-side from which fine views can be obtained of the several sections of this fall.

Almost equally fine, though of less height, are the falls on the Ache at Wildbad Gastein, where the river, flowing through narrow ravines, makes two leaps of 207 and 280 feet, and the Golling or Schwarzbach Fall on the slope of the Hohe Goll. The stream forming the latter issues from a cave 1900 feet above sea-level, and pouring through an aperture in the rock makes two leaps over a cliff about 200 feet high. A natural bridge of rock here spans the gorge into which the torrent is precipitated.

The Stuiben Fall on the Oybach in southern Bavaria, near Oberstdorf, the Partnach Fall near the Zugspitze, the highest peak of the Bavarian Alps, the Kitzloch Fall of 330 feet in four leaps, the Zlappfall, 260 feet, and the Jungfernsprung, 420 feet, both the latter near Dollach, and the fall below the glacier of the Gefrorne Wand, near Hunter-Tux, are all worth seeing, not to mention many others.

Perhaps the most curious and interesting part of the region under review is the amphitheatre of Logar lying under the Grintouz, the main peak of the Karawanken. It bears a marked resemblance to the *cirque* of Gavarnie. A number of waterfalls plunge down over its precipitous sides, of which the Krinka is said to descend nearly 1000 feet in three leaps.

Lastly there are the underground rivers near the Adriatic seaboard in the curious plain known as the Karst, which is intersected by limestone gorges. Many of these streams here have subterranean waterfalls, such as the River Rieka, or Recca, anciently known in its lower course as the Timávo, and celebrated among the ancients who erected temples on its banks.

After disappearing through a cliff 320 feet high, it forms a number of grottoes and falls passing from one to another through narrow gorges. There are said to be as many as eighteen separate falls, and its course underground extends for nearly 20 miles. Its flood volume may be very considerable. In the "sink" of

Trebić, for instance, according to Reclus, it has been observed to rise 350 feet in a time of sudden floods. Other streams which display the like characteristics are the Ombla, the Kerka and the Narenta, etc.

Coming to Italy, I have already referred to the famous falls of Terni, which were at one time considered to be the finest in southern Europe, though originally they were not natural cascades but were created by human agency. Their waters were already much depleted when I visited them many years ago, and I am told that to-day they are no longer worth seeing, even on holidays, when some of the volume is temporarily again diverted over the precipice. The water is used to-day by various factories for the making of ordnance, nitrogen, carbide, as well as for cotton-spinning, etc. It also supplies Rome with electric light, and power for the city's tramways.

The Velino, which is a tributary of the Nera, or Nar, described by Virgil as "sulfurea albus aqua," owing to its white appearance on account of the lime and sulphur it contains, used to choke up its bed with the calcareous sediment it brought down, so that the ancient plain of Reate was frequently devastated with floods. To remedy this state of things, Curius Dentatus, the conqueror of the Sabines in 290 B.C., cut a new channel for the river, conducting it to the precipice over which it thenceforth plunged into the Nera; and thus the famous Cascata della Marmore originated. The mischief, however, was then transferred to Interamnæ, and years later, about 27 B.C., a law-suit ensued in which Cicero took part on the side of the Reate populace. Subsequently the original channel of Dentatus itself filled up, but in 1785 a new one was made by Braccio da Montone, which has satisfactorily answered its purpose. In their former unspoilt state the falls dropped from an aggregate height of about 585 feet in three leaps of 330, 65 and 190 feet respectively, and presented an extremely fine spectacle, as Byron's eulogy of them, which I have quoted in my first chapter, sufficiently indicates.

The equally well-known falls of Tivoli on the Anio also owe their origin to the diversion of the river on account of the damage done by its floods, to obviate which a double tunnel was cut through the western slope of Monte Catillo by the architect Folchi in the early years of the nineteenth century. As in the case of the Velino Falls, however, these, too, have now become so much depleted for supplying power for electricity as scarcely to be longer worth visiting. The so-called "New Fall" which

Folchi's tunnels created was 355 feet in height. The former beauty of the surroundings of these cascades has long been so well known to all who have travelled in Italy that any description of them here would be superfluous.

Finally, to conclude our long survey, we come to our own waterfalls in the British Isles, the great majority of which, of course, are but very slender cascades, though as far as the surroundings of many of them are concerned they can vie in beauty on their smaller scale with many of their greater brethren. This particularly applies to a number of the falls in Wales and the Lakes district, though in neither locality does there exist what could be termed an imposing waterfall, so slight is the volume of the various streams on which they occur.

I think it will hardly be disputed that the most arresting waterfalls south of the Tweed are High Force and Cauldron Snout, both of which are within a few miles of each other and on the same river, to wit, the Tees. There is here always a fair amount of water, but when the river is in high spate both these falls would be considered worthy of more than passing notice anywhere.

The accompanying views of High Force, for which I am much indebted to Mr. M. Richardson of Middleton-in-Teesdale, as well as for the view of Cauldron Snout, will give the reader some idea of what the Tees can do when it really rises in its might. To anyone who has seen the falls only at low water, at which time there is no water at all passing over them to the left side of the great rock in the centre as one faces downstream, it would seem almost incredible that the river would ever rise to such an extent as to cover the rock itself. Yet, as one of the photographs here shows, such was the case in September, 1926, after several consecutive weeks of heavy rain.

A comparison of this view with the one taken in February, 1929, showing the fall frozen over, will convey some notion of the quantity of the volume at the former period. The top of the large dividing rock is about 78 feet above the ordinary level of the pool below. It is of an unusual geological structure, the upper part of it being of basalt with vertical joints, and the lower part of limestone with horizontal layers. One can, of course, easily step on to it when the stream is low, but care is necessary, as its surface is extremely slippery as I can testify. Some years ago three people ventured upon it at a time when the river was fairly high, but one of them fell off and was drowned. The ravine below the falls, and, indeed, the whole surroundings, which are admirably kept

[illegible]

up by Lord Barnard, who owns the property, is extremely picturesque.

Cauldron Snout, which is set amidst bleak moorlands farther up the river, and some 1600 to 1800 feet above sea-level, has an entirely different aspect to High Force, and though its surroundings are not so pretty I am not at all sure but that it is the more impressive of the two falls. Above the falls, the Tees is almost motionless for nearly 2 miles, as here it broadens out into a long expanse of still water known as the Weel. It is said that this stretch of the river inspired Martin, the well-known illustrator of Milton's *Paradise Lost*, with the idea of his famous picture "The Plains of Heaven."

The Snout is a slanting basaltic cleft in the hills, down which the river surges in a roaring succession of cascades, dropping about 200 feet in a distance of from 400 to 500 yards. This cleft winds and twists in such a way that it is impossible to get a complete view of the whole descent at one glance. The one here reproduced shows the final leap at the foot of the fall. Cauldron Snout is said to be the highest fall in England, though, as I have pointed out, it is not a sheer leap in the clear. Its bleak, moorland setting makes it singularly memorable.

Coming to Scotland, the name of Foyers will at once be recalled to the mind of the older generation, a fall which Coleridge described as "one of the five finest things in Scotland," and which was immortalised by Robert Burns, who saw it on September 5th, 1787, in the following lines:

"Among the healthy hills and ragged woods
The foaming Fyers pours his mossy floods;
Till full he dashes on the rocky mounds,
Where, thro' a shapeless breach, his stream resounds.
As high in air the bursting torrents flow,
As deep recoiling surges foam below,
Prone down the rock the whitening sheet descends,
And viewless Echo's ear, astonished, rends.
Dim seen, through rising mists and ceaseless show'rs,
The hoary cavern, wide-surrounding, low'rs.
Still thro' the gap the struggling river toils,
And still, below, the horrid cauldron boils."

Professor Wilson described it as "the most magnificent cataract, out of all sight and hearing, in Britain." But, alas, in 1895, in spite of loud protests from many famous men and lovers of natural scenery, the falls were handed over to the tender mercies of an Aluminium Company and are to-day so depleted as scarcely any longer to be worth seeing. At the time when they were about to be harnessed, it is recorded that an agent of the Company in question made the priceless statement that "the falls will not be injured, only there will be no water in them!" Before they were thus sacrificed for cheap power, the falls of Foyers consisted of two leaps, the upper one of 30 feet, and the lower one of 90 feet; the volume, also, was respectable. The gorge through which the torrent descended with its birchwoods and other trees was remarkably fine.

I am not sure, however, that I should have been in entire agreement with Professor Wilson's contention that Foyers was "the most magnificent cataract, out of all sight and hearing, in Britain." The Grey Mare's Tail, near Moffat, which comes down from Loch Skene, 1700 feet above sea-level, is certainly much higher; while the falls of Glomach near Strome Ferry are probably the highest of all our British falls; though Foyers no doubt exceeded them both in volume.

The first is alluded to by Scott in *Marmion*:

> "Where, deep deep down, and far within,
> Toils with the rocks the roaring linn;
> Then, issuing forth one foaming wave,
> And whirling round the Giant's Grave,
> White as the snowy charger's tail,
> Drives down the pass of Moffatdale."

The height of the Grey Mare's Tail is generally estimated at about 200 feet. Glomach, however, plunges down for 370 feet; and though the burn has but slight volume at ordinary times, it is impressive when in spate and then provides a spectacle, as it shoots down over the black precipices, that is said to be one of the finest of its kind in our islands. Some time ago this fine fall was threatened with obliteration by the Grampian Hydro-electric scheme which would appear to involve the damming of the streams which feed it, not to mention, incidentally, the spoliation of Glens Affric, Cannich and Strathfarrar. I believe, however, that the project has been shelved.

Another fall in Scotland of considerable height, which is not much visited, is that of Eas-Coul-Aulin on the south side of Loch Glencoul and near its head, which is said to drop about 300 feet.

Lastly we may mention the well-known falls on the Clyde, now also harnessed, as in their original state it is not improbable that they had the largest volume of any British waterfalls. From figures kindly supplied to me by the Clyde Valley Electrical

Power Company, the mean discharge is from 928 cusecs to 1113, with a normal high water flow of 3713 cusecs. The highest recorded volume has reached 4530 cusecs, a by no means negligible quantity. They are, of course, so well known as scarcely to need any description here. The combined head of the Bonnington and Corra Linn Falls is 189 feet, and that of the Stonebyres Fall 97½ feet, the difference between the working head given above and the actual fall being about 10 feet. Corra Linn, set in an amphitheatre of rock, is the highest of the three and descends about 86 feet.

In Ireland the well-known Powerscourt Fall, though of some height, has but a meagre volume, and more impressive are the cascades on the Liffey, known as Pollaphuca (the Puck's or Devil's Hole), which drop altogether about 150 feet on a width of 40 feet. The name Pollaphuca, or Poul-a-Phouca, is more correctly applied to the round basin into which the water plunges at the foot of the falls. This " Pool of the Demon Horse " has a vortex in it, which local legend affirms is the haunt of the Phouca, a malignant sprite in the form of a horse who lures half-drunken wights to mount on his back and then dashes away with them over bogs and precipices.

We will here conclude our review of the notable waterfalls of the world. There are no doubt many others worthy of mention, but I think we have included all those of any consequence. As I mentioned in my first chapter, I append hereafter a table showing the figures for the volumes and dimensions of those falls which I have termed " Giant " Falls, as far as such are available. It would be interesting, were it possible, to have the various impressions of a dozen persons of average discernment of all these great falls at their respective high- and low-water seasons, and to compare them one with another. That there would be very considerable difference of opinion as to which would have made the most appeal is fairly certain. So much, moreover, would depend on their extremely diverse surroundings.

A well-known writer has said of waterfalls generally that though they are noble objects as forming part of a landscape, they are often so situated as to be well seen only when every other part of the landscape is excluded ; and he has further contended that if dwelt upon exclusively a waterfall becomes " a mere *lusus naturæ* " and not an element of scenery. This criticism, I venture to think, may especially apply to the great wide falls which stand out from and so dwarf their surroundings that they make the beholder oblivious to the latter, whatever charms or otherwise they may possess, and irresistibly arrest his whole attention.

To many, no doubt, the far superior heights of Kaieteur and Gersoppa, in comparison with the rest, would award either of these the palm. To others the infinite variety and beauty of such falls as those of the Iguazu or Cauvery or Victoria might make most appeal. There can be little doubt, however, that the Aughrabies Falls on the Orange would be voted the most desolate and, if one may use such a word, the most malign ; nor that, in so far as unchained power and might can impress the mind, the recollections of Guayra, and still more of Paulo Affonso, would remain the most perdurable. And yet the suspicion arises whether, after all, one of the most famous of the Norwegian waterfalls, the wondrously lovely Skjaeggedalsfoss, though of far inferior volume to any of our Giants, might not for sheer changeful beauty be held to surpass them all.

A COMPARISON OF THE DIMENSIONS OF SOME OF THE GIANT FALLS

(As a scale of comparison for volume the mean annual flow of the Thames at Teddington is approximately 2500 cusecs. In a moderately high flood this may be increased to 10,000 cusecs, and in an exceptionally high flood, such as that of December, 1929, to some 19,400 cusecs.)

			Volume in cubic feet per second.			
Fall.	*Height in feet.*	*Width in yards.*	*Minimum Volume.*	*Mean Annual Volume.*	*Average Flood Volume.*	*Extreme Flood Volume.*
Guayra . .	90 to 130	5,280 (plus) (including the intersecting islets)	375,000	470,000	800,000 to 1,000,000	1,765,798 (approx.)
Iguazu . .	237 (mean)	3,300 to 4,374 (including the islands)	7,381	61,660	167,498	452,019
Paulo Affonso	275	19 (brink of main fall)	35,000	100,000 (approx.)	200,000 (plus)	500,000 (plus)
Kaieteur .	741	40 to 123	?	23,400	?	?
Niagara .	158 to 175	1,316 (exclusive of Goat Island)	158,500	212,200	?	292,000

Grand Falls	316	50	?	30,000 to 40,000 (?)	50,000 (approx)	?
Shoshone	220	330	4 400	10,064	26,000	53,100
Aughrabies	450 to 480	20 main falls	100 or less	11,050	?	500,000
Victoria .	236 to 354	1534 exclusive of islands)	8,000	38 430	82,000	250,000 (approx) record flood of 1934
Rua Cana	406	50 to 760	500	?	40,000	?
Khon Cataracts	50 to 70	13,123 to 14 217 overall)	317,833	400,000 to 420,000 approx)	?	1,765,738 (approx)
Cauvery	182 to 209	418 mean)	50 to 200	33,000	239,000	667,470
Gersoppa	829	17 to 800 approx	6	5 387	?	120,000

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